Berryessa Creek Project

Santa Clara County, California

Appendix C

Economics

DECEMBER 2013

BERRYESSA CREEK PROJECT
APPENDIX C, ECONOMICS

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CHAPTER 1: INTRODUCTION

1.1   Purpose and Scope

The purpose of this report is to present the results of the economic analysis performed for the General Reevaluation study of the Berryessa Creek Project. The report documents the reevaluation of benefits and costs of the authorized project in comparison with potential changes in design, benefits, and costs for a modified project and alternative plans. This information is necessary to determine the extent of Federal interest in a modified or new plan for flood damage reduction along Berryessa Creek. The report presents findings related to flood risk, potential flood damages and potential flood risk management benefits.

1.2   Study Area

The study area is located in Santa Clara County California. Berryessa Creek runs through the cities of Milpitas and San Jose, an urbanized alluvial plain that includes a diverse mix of residential, commercial, industrial, and public land uses. The population of Milpitas and San Jose are 67,476 and 958,789 respectively (source: California Department of Finance, E-1 May 2011.) The area is part of California's Silicon Valley, with many computer, bio-tech and hi-tech firms located in the area.

1.3   History of Flooding

Recent flood events from Berryessa Creek include those in March 1982, January 1983 and February 1998. It was reported that the 1998 event caused minor damages to homes and automobiles but dollar losses were not documented. No non-residential structure losses were reported from these events. Specific frequency was not identified for floods within the study area but each noted event was believed to be smaller than the 0.10 exceedance probability event.

1.4   Consistency with Regulations and Policies

This economic analysis is in accordance with standards, procedures, and guidance of the U.S. Army Corps of Engineers. The Planning Guidance Notebook (ER 1105-2-100, April 2000) serves as the primary source for evaluation methods of flood risk management studies and was used as reference for this analysis. Additional guidance for risk-based analysis was obtained from EM 1110-2-1619, *Engineering and Design – Risk-Based Analysis for Flood Damage Reduction Studies (August 1996)* and ER 1105-2-101, *Planning - Risk Analysis for Flood Damage Reduction Studies (January 2006)*.

1.5   Price Levels, Period of Analysis, and Discount Rate

Unless otherwise noted, all values in this document are presented in October 2013 prices, and amortization calculations are based on the Fiscal Year 2014 federal discount rate of 3.50

percent as published in Corps of Engineers Economic Guidance Memorandum 14-01. Economic evaluation was performed over a 50-year period of analysis with a base year of 2017.

CHAPTER 2: FLOODPLAIN AREA AND INVENTORY

2.1   Economic Data Area

The study area was divided into six economic impact areas for economic evaluation and project performance purposes. Delineations were made to address changes in hydrology, hydraulics and economic conditions throughout the creek. A map showing the six impact areas is shown in Figure 2.1. A comparison of the impact areas to the linear study reaches is provided in Figure 2.2.

- Area A lies farthest east and runs from Old Piedmont to the intersection of Cropley Avenue and Piedmont Road. The area consists of single family residences.

- Area B includes Cropley Avenue and runs along the right bank from Piedmont to Morrill Avenue. The area is primarily residential.

- Area C runs along the left bank just past Majestic Elementary and Berryessa Creek Park downstream just east of Morrill. The area is primarily residential.

- Area D runs from Morrill to the I-680 Freeway. This area in San Jose is primarily residential.

- Area E is the largest impact area in the study and begins just west of I-680. The area is bounded by Capitol Avenue, Abel Street and Berryessa Creek. This area includes the Midtown region of Milpitas and includes residential, commercial, public and industrial land uses.

- Area F runs along a short section of the left bank of Berryessa from Yosemite Drive to near Los Coches Street and east of WP railroad line. This impact area is highly industrial with many hi-tech firms in addition to some commercial and limited residential.
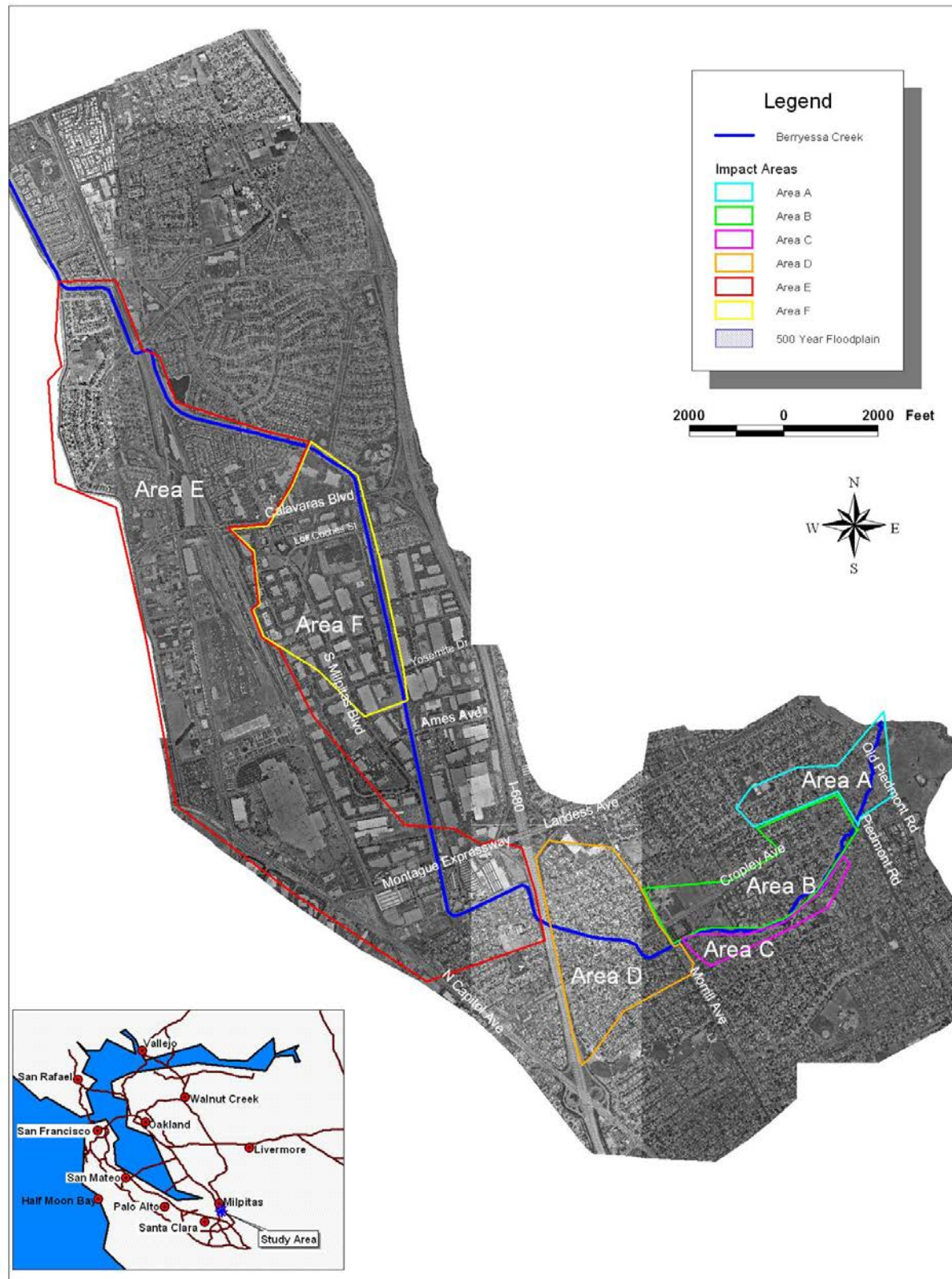
Figure 2.1   Economic Impact Areas
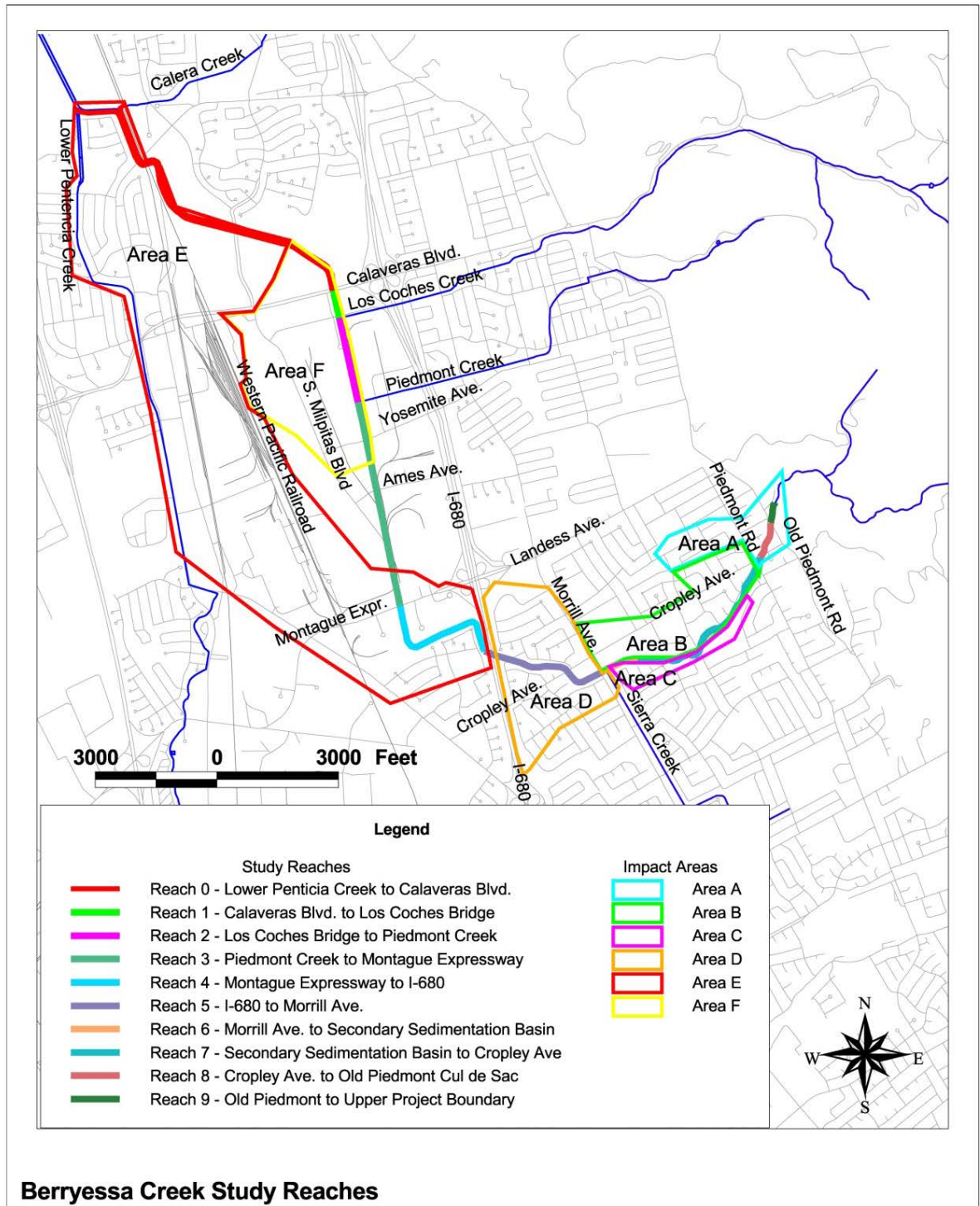
Figure 2.2   Study Reach and Impact Area Locations

2.2   Inventory of Structures and Property in Study Area

A structural inventory was previously completed based on data gathered from assessor's parcel data and on-site inspection of all the structures (100%) within the floodplain. Structures were determined to be within the economic study area by using Geographical Information Systems (GIS) to compare the 0.002 exceedance probability floodplain boundary with the spatially referenced assessor parcel numbers (APN). The inventory was developed in accordance with Section 308 of WRDA 1990.[1] Information from the assessor's parcel database (such as land use, building square footage, address) was supplemented during field visitation for each parcel within the floodplain to collect additional required data such as, foundation height, specific business activity (non-residential), building condition, type of construction, number of units. Parcels with structures were categorized by land use and grouped into the following structural damage categories:

1) **Single Family Residential** – includes all parcels represented by a single unit such as detached single family homes, individually owned condominiums and townhouses.
2) **Multiple Family Residential** – includes residential parcels with more than one unit such as apartment complexes, duplexes and quadplex units. Each parcel may have multiple structures.
3) **Commercial** – includes retail, office buildings, restaurants
4) **Industrial** – includes warehouses, light and heavy manufacturing facilities. Also includes many computer and bio-tech industries that are in the Milpitas area.
5) **Public** – includes both public and semi-public uses such as post offices, fire stations, government buildings, schools and churches.

All parcels with structures were assigned to one of the listed categories. Some parcels have more than one physical structure and some structures, such as condominiums, are represented by multiple parcels. Table 2.1 displays the total number of parcels (number of units for multifamily residential) with structures by category.

[1] Section 308 instructs the analysis to not include any new or substantially improved structure (other than a structure necessary for conducting a water-dependent activity) built in the 100-year flood plain with a first floor elevation less than the 100 -year flood elevation after July 1, 1991

Table 2.1   Structural Inventory

Number of Parcels With Structures within the 0.002 Exceedance Probability Floodplain By Land Use						
Economic Impact Area	**Single Family Residential**	**Multiple Family Residential Units**	**Commercial**	**Industrial**		**Public**	**Total**
				General	**Tech**		
Area-A	64	0	0	0	0	0	64
Area-B	96	287	0	0	0	1	384
Area-C	14	0	0	0	0	0	14
Area-D	378	105	0	0	0	0	483
Area-E	723	1,110	95	22	17	15	1,982
Area-F	1	0	14	8	25	4	52
Total	**1,276**	**1,502**	**109**	**30**	**42**	**20**	**2,979**
Number of Parcels With Structures within the 0.010 Exceedance Probability Floodplain By Land Use							
Area-A	35	0	0	0	0	0	35
Area-B	77	257	0	0	0	1	335
Area-C	12	0	0	0	0	0	12
Area-D	231	26	0	0	0	0	257
Area-E	589	1,050	82	22	16	13	1,772
Area-F	1	0	14	8	25	4	52
Total	**945**	**1,333**	**96**	**30**	**41**	**18**	**2,463**

In total there are 1,000 more units at risk than shown in the 1987 Feasibility report. The biggest difference is multi-family residences that have increased in the area.

2.3   Value of Damageable Property - Structure Value

The value of property at risk was estimated based on depreciated replacement values (DRV). Structure value was determined based on the following function:

DRV = Square Footage * Cost per Square Foot * Depreciation Factor

Evaluations of Corps flood risk management projects require structures be valued using replacement costs minus depreciation. These values may differ from assessed values, sales or market values, reproduction costs or values determined by income capitalization. Depreciated replacement cost does not include land values and market prices (which include land value) or sale price for homes and commercial property would be higher than the value of the depreciated structure alone.

Building characteristics such as quality type, condition, and number of stories were gathered for each parcel. Square footage representing the building area was taken from assessor's parcel data for each structure. Values for cost per square foot were determined based on land use, building type, construction class and quality.

Values were taken from the Marshall and Swift (M&S) Valuation Service and were adjusted using the M&S local multipliers for San Jose to account for the higher construction costs found in the Milpitas/San Jose area. Factors such as the year the structure was built, overall condition of the building, improvements, required maintenance and comparative data from other studies were used in determining the subjective measure of how much depreciation to assign each structure.

In the database, each structure was assigned a mean remaining value percentage (100% replacement minus estimated percent depreciated) to be used in determining depreciated replacement value. The range of depreciation varied with each structure and land use with new structures assigned zero depreciation and a maximum of 60% for a few structures in poor condition.

Uncertainty in remaining percent value was determined to be a triangular distribution with minimum and maximums set at plus or minus 10% not to exceed 100% total value. Examples of a typical structure valuation by damage category using median values found in this study are shown in Table 2.2. These values are displayed to explain the methodology used but do not represent any particular structure or mean values within the study.

Table 2.2   Valuation Example

Depreciated Replacement Value, October 2013 Prices Using Typical Structures by Category					
Structure Category	**Square Footage**	**Price Per Square Foot (locally adjusted)**	**Estimated Depreciation Percentage**	**Remaining Value Percentage**	**Depreciated Replacement Value of Typical Structure**
	Using Median Values By Category				
Single Family Residential	1,480	$144.08	15%	85%	181,247
Multiple Family Residential Units	1,900	$96.41	30%	70%	128,219
Commercial	4,680	$144.74	15%	85%	575,759
Industrial	11,870	$147.49	15%	85%	1,488,051
Public	10,000	$182.52	10%	90%	1,642,674

2.4   Value of Damageable Property- Content Value

In addition to structures, building contents can also be at risk of flood damages. For this study, content values were estimated as a percentage of depreciated structure value based on land use. During the 1992 General Design Memorandum (GDM) on Berryessa Creek, detailed content surveys were made to determine content percentages specific to the Milpitas/San Jose area. For this reevaluation study, no additional content surveys were completed to confirm or adjust values used in the original study.

The 1992 GDM survey requested identification of business activity, square footage or known value of the building, total value of content or ratio content to structure value if known. The survey also asked respondents to provide estimated loss of contents for various theoretical floods. As no known flood events have occurred in the study area resulting in non-residential damage, responses were limited to best guess estimates. Based on these survey results, the 1992 GDM content percentages were considered to be reasonable. Minor adjustments were made to the industrial category (sub-divided for content analysis only in this study as Industrial-General and Industrial-Tech) to represent the recent surveys. The industrial-tech content category includes computer component manufacture and distribution, and bio-technology commonly found in the San Jose/Milpitas area. Both content values and percent losses were greater for the industrial-tech than typical industrial activities, which is why industrial content losses were separated for this analysis. The sub-categories for commercial business only differ in the assigned content percentages (does not affect structure depth-damage functions). Content percentages by sub-category are given in Table 2.3.

Table 2.3   Content to Structure Ratios

Structure Sub-Category	Content Percent of Structure Value
Commercial-Food	130 %
Commercial-Office	50 %
Commercial-Retail	100 %
Commercial-Restaurants	75 %
Commercial- Department Stores	150 %
Industrial-General	131 %
Industrial- Tech	187 %
Public	45 %
Residential	50 %

Total value of damageable property is comprised of the structural and content values described for the parcels within the 0.002 exceedance probability floodplain. Table 2.4 shows the total structure and content values by category and economic impact area. In total, the study area has just under $2.3 billion worth of estimated damageable property. Total value of over $1 billion for structures within the floodplain is over eight times the value found in the 1987 Feasibility study. Factors leading to these increases include: additional structures, general increases in valuation from 1986 to 2013, improvements in existing structures and increased labor and construction costs in the area.

Table 2.4   Value of Damageable Property

Within the 0.002 Exceedance Probability Floodplain Values in $ Millions, October 2013 Prices							
Structure Category	**Area-A**	**Area-B**	**Area-C**	**Area-D**	**Area-E**	**Area-F**	**Total**
SFR-Structure	11.7	17.6	2.4	63.3	123.3	0.4	218.7
SFR-Content	5.8	8.8	1.2	31.7	61.7	0.2	109.4
MFR-Structure	0.0	27.3	0.0	11.4	224.6	0.0	263.3
MFR-Content	0.0	13.6	0.0	5.7	112.3	0.0	131.6
Commercial-Structure	0.0	0.0	0.0	0.0	227.6	30.6	258.2
Commercial-Content	0.0	0.0	0.0	0.0	246.0	29.1	275.1
Industrial-General Structure	0.0	0.0	0.0	0.0	74.1	30.9	105.0
Industrial-Tech Structure	0.0	0.0	0.0	0.0	82.5	161.0	243.5
Industrial- General Content	0.0	0.0	0.0	0.0	97.1	40.4	137.5
Industrial-Tech Content	0.0	0.0	0.0	0.0	154.3	301.1	455.4
Public- Structure	0.0	8.3	0.0	0.0	30.3	14.2	52.8
Public- Content	0.0	3.7	0.0	0.0	13.6	6.4	23.7
Total Value	**17.5**	**79.3**	**3.6**	**112.1**	**1,447.4**	**614.3**	**2,274.2**

CHAPTER 3: METHODOLOGIES, DEPTH-DAMAGE RELATIONSHIPS AND FLOODING CHARACTERISTICS

3.1   Economic HEC-FDA Model and Application of Floodplain Data

The Hydrologic Engineering Center's HEC-FDA model (version 1.2.4, FRM-PCX certified model) was used to perform the economic damage and benefits analyses. More detailed descriptions about the capabilities of HEC-FDA model and how it was used are provided in the following paragraphs.

The HEC-FDA model was used to integrate the engineering data (hydrologic, hydraulic, and geotechnical), compute stage-damage curves using specially-formatted output data, and compute initial AEP and EAD results under without-project and with-project conditions.

For structure and content damages, depth of flooding relative to the structure's first floor is the primary factor in determining the magnitude of damage. Unlike previous economic analyses for the study area that employed Excel spreadsheets to determine inundation damages, the current analysis utilizes HEC-FDA's internal processes for the determination of structural inundation. The current HEC-FDA process combines a GIS database containing spatially referenced polygons for each parcel in the study area with water surface elevations developed in Flo2D for each structure.

A ground elevation was assigned to the centroid of each parcel using GIS for the study. Foundation heights, determined during field visitation, were added to the assigned ground elevation to establish first floor elevations. Water surface elevations (WSE) from the Flo2D model were provided in the form of grid cells for the 0.500, 0.200, 0.100, 0.040, 0.020, 0.010, 0.005, and 0.002 exceedance probability events. Parcels were then correlated with the grid cell in which the centroid laid. Flooding depths in general were rather shallow with very few structures facing depths greater than 3 feet and an average of one foot above ground elevation for the largest event

3.2   Computation of Stage-Damage Curves within the HEC-FDA Model

For the suite of floodplains, WSE floodplain data was formatted so that the floodplains could be directly imported into the HEC-FDA model as a water surface profile. The formatted files contained every grid cell that contained a structure and the water surface elevations in each grid cell for each frequency event. The suite of floodplains along with the imported structure inventory was used in HEC-FDA to compute stage-damage curves.

Instead of using river station numbers, assignment of water surface elevations by frequency event were completed using grid cell numbers; the grid cell assignments represent actual floodplain water surface elevations by frequency event rather than in-channel water surface elevations. Once the formatted floodplain data were imported into HEC-FDA, a row was inserted at the top of the WSP which included the in-channel stages associated with the index

point (for a particular impact area).   This step allowed for the linkage between the 2-dimensional floodplain data and the in-channel stages. Importing formatted floodplain data and assigning water surface elevations to grid cells eliminated the need for creating interior-exterior relationships, which is another way to link exterior (river) stages to interior (floodplain) stages within HEC-FDA.

3.3   Depth-Damage Relationships

Damages to structures and contents were determined based on depth of flooding relative to the structure's first floor elevation. To compute these damages, depth damage curves were developed. These curves assign loss as a percentage of value for each parcel. The deeper the relative depth, the greater the percentage of value damaged. The sources of the relationships were different depending on land use. For single family residential structures and contents, depth damage curves were taken from Economic Guidance Memorandum EGM 01-03, *Generic Depth Damage Relationships*. For the other (non-single family residential) structure categories, the damage curves were based on 1998 FEMA Flood Insurance Administration data with the exception of the industrial content curves. For industrial content, the depth damage curves used in the original Corps study were modified based on the current survey responses (see Section 2.4). The resultant depth damage curves are shown in Table 3.1 by category.

Table 3.1   Depth Damage Curves

Damage Category	Depth of Flooding – Above First Floor in Feet						
	-1	**0**	**1**	**2**	**3**	**4**	**5**
Percent Damage of Structure Value							
Commercial 1-Story	0 %	7.0 %	16.3 %	24.7 %	27.7 %	29.6 %	30.9 %
Commercial 2-Story	0 %	5.0 %	9.9 %	13.4 %	18.0 %	20.0 %	22.0 %
Industrial Gen 1-Story	0 %	7.0 %	16.0 %	25.0 %	28.0 %	30.0 %	31.0 %
Industrial Gen 2-Story	0 %	5.0 %	10.0 %	13.0 %	18.0 %	20.0 %	22.0 %
Industrial Tech 1-Story	0 %	7.0 %	16.0 %	25.0 %	28.0 %	30.0 %	31.0 %
Industrial Tech 2-Story	0 %	5.0 %	10.0 %	13.0 %	18.0 %	20.0 %	22.0 %
Public 1-Story	0 %	7.0 %	16.3 %	24.7 %	27.7 %	29.6 %	30.9 %
Public 2-Story	0 %	5.0 %	9.9 %	13.4 %	18.0 %	20.0 %	22.0 %
Residential 1-Story SF	0 %	13.4 %	23.3 %	32.1 %	40.1 %	47.1 %	53.2 %
Residential 2-story SF	0 %	9.3 %	15.2 %	20.9 %	26.3 %	31.4 %	36.2 %
Residential 2-Story Apt	0 %	9.3 %	15.2 %	20.9 %	26.3 %	31.4 %	36.2 %
Percent Damage of Content Value							
Commercial 1-Story	0 %	0 %	22.8 %	49.5 %	64.7 %	91.2 %	100.0 %
Commercial 2-Story	0 %	0 %	19.1 %	31.4 %	35.6 %	45.1 %	50.0 %
Industrial Gen 1-Story	0 %	0 %	35.2 %	64.2 %	74.8 %	91.8 %	96.3 %
Industrial Gen 2-Story	0 %	0 %	29.6 %	40.8 %	41.2 %	45.9 %	48.1 %
Industrial Tech 1-Story	0 %	0 %	35.2 %	64.2 %	74.8 %	91.8 %	96.3 %
Industrial Tech 2-Story	0 %	0 %	29.6 %	40.8 %	41.2 %	45.9 %	48.1 %
Public 1-Story	0 %	0 %	22.8 %	49.5 %	64.7 %	90.2 %	100.0 %
Public 2-Story	0 %	0 %	19.1 %	31.4 %	35.6 %	45.1 %	50.0 %
Residential[1] 1-Story SF	0 %	16.2 %	26.6 %	35.8 %	44.0 %	51.4 %	57.6 %
Residential[1] 2-story SF	0 %	10.0 %	17.4 %	24.4 %	31.0 %	37.0 %	42.6 %
Residential 2-Story Apt	0 %	5.0 %	8.7 %	12.2 %	15.5 %	18.5 %	21.3 %

[1] The EGM 01-03 curves estimate content damages as a direct function of structure value. The percentages listed in this table assume content value at 50% of structure value and percentages have been modified accordingly.

CHAPTER 4: DAMAGES BY EVENT

4.1   Damage Estimation

As previously referenced, damages were estimated within HEC-FDA employing its full function of relating structure inventory data with water surface elevations by exceedance probability events. Structure values for insertion into HEC-FDA, as mentioned in Section 2.3, were determined as a function of Marshall Valuation Service values per square foot, square footage and estimated depreciation. Structure valuations for HEC-FDA input were based on triangular distribution of Marshall Valuation factors for each structure by type of construction.

4.2   Economic Uncertainty Parameters

Many of the factors that determine flood damages can be represented by a range of values instead of a single number. Errors in measurement, variation in classification and judgment can lead to differences in values. For this study, in accordance with EM 1110-2-1619, uncertainties in the following parameters were considered in the HEC-FDA damage estimation:

- Structure Value
- Content-to-Structure Value Ratio
- First Floor Elevation
- Depth-Damage Percentage

In 2006 for the feasibility study, to estimate the uncertainty in structure valuation, triangular distributions for each of these parameters were set in the model. For a hypothetical example, a house of good construction may have a value of $115 per square foot, average construction $85 per square foot and very good $140 per square foot. The range in parameters, value per square foot for each land use type, along with range of ±10% of measured square footage and ±10% estimated depreciation were used in the Monte Carlo simulation to determine both the coefficient of variation (standard deviation divided by the mean) and distribution of structure valuation. For all land uses, the Monte Carlo simulation was evaluated in @RISK BEST FIT which indicated a normal distribution provided the best fit with the following coefficients of variation:

- Single Family Residential = 12 %
- Multi-Family Residential = 14 %
- Commercial = 12 %
- Industrial = 16 %
- Public = 16 %.

Content damages were estimated as a percentage of structure value. For residential contents, these percentages were taken as direct function of structure value and determination of content ratio was not required (see EGM 01-03). For industrial content percentages, the

uncertainties were taken from the survey results with a logistic distribution providing the best fit with a standard deviation of 25% for Industrial-General and 35% for Industrial-Tech. Commercial and public content uncertainties were set equal to structure percent (based on findings from other studies to include Hamilton City, Sacramento River-Phase V, Sacramento and San Joaquin River Comprehensive study) and ranged from 12% to 16% fitting a normal distribution.

The GRR's database was developed through an assessor's parcel database with an onsite survey (Section 2.2 Economic Appendix). Foundation heights come from the survey and topographic data was developed within GIS mapping of land and parcel boundaries. Uncertainty in first floor elevation was based on topography used in both the hydraulics and structural analysis. The standard deviation of first floor elevation was estimated at 0.1 feet in accordance with EM 1110-2-1619.

For single family residential depth-damage functions, uncertainties were based on the standard deviations provided in EGM 01-03 (varies by depth, with a maximum of 5%). Uncertainties for depth-damage percentages for commercial, industrial and public structures were triangular error functions based on prior Sacramento District studies.

4.3   Other Damage Categories

In addition to damages directly related to structures and their contents, losses were estimated for other categories such as damages to automobiles and emergency costs. While economic uncertainties for these damage categories are not specifically identified or required in EM 1110-2-1619, uncertainty parameters for these categories were included in this study.

Losses to automobiles were determined as a function of the number of vehicles per residence, average value per automobile, estimated percentage of autos removed from area prior to inundation, and depth of flooding above the ground elevation. Depth-damage relationships for autos were taken EGM 09-04. Source of vehicle counts per housing unit were taken from the US Census 2000 (San Jose and Milpitas averages). Evacuation (autos moved out of the flooded area) was assumed to be a triangular distribution with the most likely value set at 50%. The assumption is that there are many factors that could determine ability to evacuate and 50% has been used as an average on most Sacramento District studies. Depreciated replacement value of autos was based on average used car prices (taken from prior studies and updated using Bureau of Labor Statistics CPI-Used Vehicles) and was set at $12,250. This value within HEC-FDA was assumed to be normally distributed with a standard deviation of 30%.

Emergency costs were estimated for the relocation and emergency services provided for those displaced both during the peak flood event and during post-flood structural renovations. Duration of services was formulated for two groups: short-term- residents evacuated for the duration of the flood but able to stay in the home once the flood recedes, and long-term- occupants displaced from the home due to inundation requiring repair and decontamination prior to return. Losses per resident per day were taken from prior

Sacramento District studies (Napa River, South Sacramento County Streams) with a mean of $12 per day. Long-term dislocation was estimated based on a triangular distribution with the most likely value set at 45 days. Occupants per residential unit were taken from the US Census 2000 for the Milpitas area. Based on these estimates, a residence inundated above the first floor requiring repair would face an average $1,950 in total emergency costs which is reasonable for the magnitude of flooding in the study area and is less than the national FEMA average for temporary rental and public assistance.

4.4   Stage-Damage Functions

Base damages (calculations without considering uncertainty, levees, or top of bank elevations) were estimated by the HEC-FDA model for each category by impact area and by event based on varying depths within the floodplain relative to individual structures. These damages are contained in the output file *FDA_StrucDetail.out* for each impact area displayed in the following tables.

Table 4.1   Stage-Damage Functions Impact Area A

Damages in $1,000's, October 2013 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	213.7	214.28	215.12	216.88	219.26	220.15	221.39	222.31
Single Family Residential	0	86	86	87	159	707	1,191	1,350
Multi-Family Residential	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0
Automobile	0	11	12	12	19	76	130	144
Emergency	0	4	4	4	5	13	16	20
Total	**0**	**101**	**102**	**102**	**183**	**796**	**1,337**	**1,514**

Table 4.2   Stage-Damage Functions Impact Area B

Damages in $1,000's, October 2013 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	146.06	146.79	147.06	147.49	147.69	147.74	147.81	147.83
Single Family Residential	0	0	0	0	933	2,410	3,093	3,504
Multi-Family Residential	0	0	0	835	2,552	4,097	5,212	5,829
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	29	1,003	1,620
Automobile	0	0	0	81	445	970	1,310	1,580
Emergency	0	0	0	26	197	387	493	594
Total	**0**	**0**	**0**	**942**	**4,127**	**7,893**	**11,112**	**13,127**

Table 4.3   Stage-Damage Functions Impact Area C

Damage Category	Damages in $1,000's, October 2013 Prices							
	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	145.40	146.09	146.34	146.70	146.89	146.91	146.93	146.94
Single Family Residential	0	0	0	10	28	197	244	325
Multi-Family Residential	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0
Automobile	0	0	0	0	3	21	27	35
Emergency	0	0	0	0	0	3	7	8
Total	**0**	**0**	**0**	**10**	**31**	**221**	**278**	**368**

Table 4.4   Stage-Damage Functions Impact Area D

Damage Category	Damages in $1,000's, October 2013 Prices							
	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	146.06	146.79	147.06	147.49	147.69	147.74	147.81	147.83
Single Family Residential	0	53	54	253	1,019	4,534	9,726	13,797
Multi-Family Residential	0	0	0	0	0	382	1,637	2,857
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0
Automobile	0	5	5	18	81	627	1,640	2,548
Emergency	0	2	3	3	11	151	415	630
Total	**0**	**60**	**61**	**274**	**1,111**	**5,694**	**13,418**	**19,832**

Table 4.5   Stage-Damage Functions Impact Area E

Damages in $1,000's, October 2013 Prices								
Damage Category	**Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)**							
	0.500	**0.200**	**0.100**	**0.040**	**0.020**	**0.010**	**0.005**	**0.002**
	61.63	**62.59**	**63.58**	**64.50**	**64.71**	**64.86**	**65.01**	**65.07**
Single Family Residential	0	0	21	2,076	4,700	12,538	20,529	25,199
Multi-Family Residential	0	0	0	0	661	5,007	6,749	9,849
Commercial	0	0	495	2,584	5,516	9,622	14,069	22,190
Industrial	0	0	3	3,539	8,499	15,771	22,612	26,822
Public	0	0	21	96	428	1,074	2,476	3,885
Automobile	0	0	4	265	848	2,474	4,076	5,015
Emergency	0	0	0	10	105	446	867	1,101
Total	**0**	**0**	**544**	**8,570**	**20,757**	**46,932**	**71,378**	**94,061**

Table 4.6   Stage-Damage Functions Impact Area F

Damages in $1,000's, October 2013 Prices								
Damage Category	**Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)**							
	0.500	**0.200**	**0.100**	**0.040**	**0.020**	**0.010**	**0.005**	**0.002**
	36.80	**37.76**	**37.86**	**38.13**	**38.21**	**38.31**	**38.33**	**38.35**
Single Family Residential	0	0	0	0	0	0	40	40
Multi-Family Residential	0	0	0	0	0	0	0	0
Commercial	0	430	762	734	1,424	2,882	3,508	3,812
Industrial	0	12,778	26,885	46,679	57,869	71,041	86,511	93,074
Public	0	11	432	486	507	1,134	1,368	1,385
Automobile	0	0	0	0	0	0	0	0
Emergency	0	0	0	0	0	0	0	0
Total	**0**	**13,220**	**28,079**	**47,898**	**59,800**	**75,057**	**91,426**	**98,311**

CHAPTER 5: FUTURE ECONOMIC DEVELOPMENT

5.1   Midtown Redevelopment

The city of Milpitas currently has a redevelopment plan for Midtown area, with some of the land lying within economic impact area E of this study. Primarily along the South Main and Abel Street corridors, the plan calls for renovation of many of the existing buildings and new high density residential and commercial construction on existing vacant acres near light rail and proposed BART stations. This area is the only portion of the study floodplain identified for future growth. Development is projected to be complete by 2020.

5.2   Vacant Acres and Proposed Land Use

Land use plans for the Midtown area were taken from the Milpitas Midtown Specific Plan (MMSP) (April 2002) and were compared with vacant parcels within the impact area. The MMSP identifies location specific use and density. Nearly fifty acres were identified for residential development ranging from medium to very high density multi-family. Most of the commercial redevelopment involved existing structures but parcels were identified with just over seven vacant acres for new commercial. Based on these acreages and densities found in the MMSP, about 1,900 of the Midtown's proposed 4,800 residential units could be in the floodplain and around 83,000 square feet of new commercial buildings. Values per square foot were taken from M&S by structure type and structure values were determined based on the estimated square footage (without any depreciation). With over 2,000,000 square feet of additional multi-family units, future residential structures were estimated at over $200 million. Future commercial structures were valued just over $10 million. Total additional value to the future inventory of damageable property was estimated to be over $320 million including both residential and commercial structure and content.

5.3   Inundation Damages – 100-year Event

In accordance with Corps guidance (reference ER-1105-2-100 paragraph E-19j), no structural damages were estimated for future development from the 100-year event. The analysis assumes that all construction would have ground elevations raised one foot above the 100-yr water surface elevation and typical construction would occur over this elevation for commercial and residential structures in compliance with this guidance.

CHAPTER 6: EXPECTED ANNUAL DAMAGES – WITHOUT-PROJECT CONDITIONS

6.1   HEC-FDA Model

Expected annual damages were estimated using the US Army Corps of Engineers risk-based Monte Carlo simulation program called HEC-FDA.   The HEC-FDA program integrates hydrology, hydraulics, geo-technical and economic relationships to determine damages, flooding risk and project performance. Uncertainty is incorporated for each relationship, and the model samples from a distribution for each observation to estimate damage and flood risk. The Berryessa Creek model includes the following relationships for each economic impact area:

- Probability-Discharge (with uncertainty determined by period of record)
- Stage-Discharge (stage in the channel with estimated error in feet)
- Stage-Damage (computed internally within HEC-FDA)

These relationships for each economic impact area are shown in Attachment A of this economic appendix.   The hydrologic and hydraulic data was provided by study team members and included in the HEC-FDA model.

6.2   Estimation of Expected Annual Damages

HEC-FDA integrates the probability-discharge, stage-discharge and stage-damage relationships to determine a probability-damage function. Expected annual damages (EAD) are calculated as the numerical integration of the area under the probability-damage curve. The dotted lines in the Figure 6.1 below represent the uncertainty band around each relationship with EAD represented as the area under a range of simulated damage-probability curves.
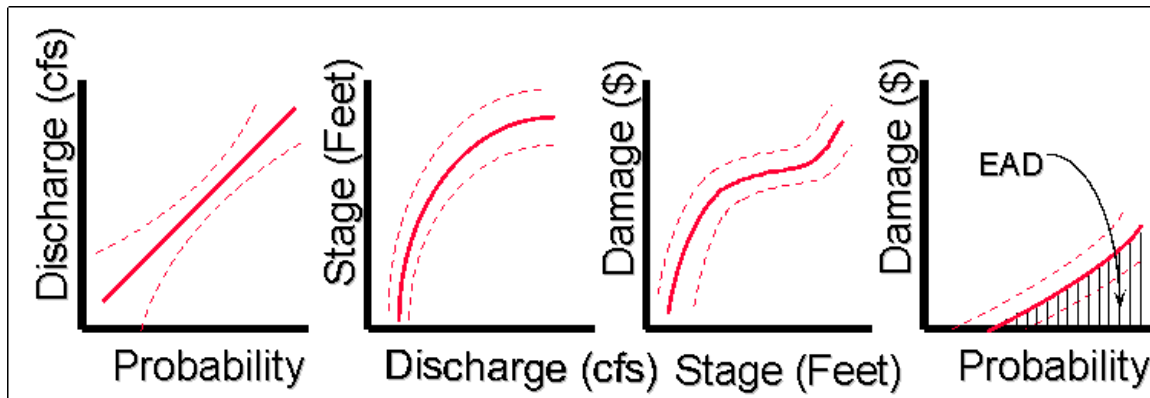
Figure 6.1   Uncertainty in Discharge, Stage and Damage in Determination of Expected Annual Damages

The derived probability damage function from the HEC-FDA model for each impact area is provided in Table 6.1. These damage values differ from the calculated damages by event shown in the stage-damage curves due to uncertainties in each relationship.

Table 6.1   Without-Project Probability Damage – HEC-FDA Model

October 2013 Prices, in $ 1,000's						
Exceedance Probability	**Total Damages by Economic Impact Area**					
	A	**B**	**C**	**D**	**E**	**F**
0.200	0	0	0	0	0	0
0.100	0	221	11	116	0	0
0.050	0	11,423	506	13,475	4,522	0
0.040	0	15,046	659	18,765	15,843	0
0.020	171	22,292	967	29,346	141,546	102,657
0.015	333	24,104	1,043	31,991	228,245	157,756
0.010	837	25,916	1,120	34,636	314,944	212,855
0.004	1,447	28,089	1,212	37,810	418,983	278,974
0.002	2,897	28,814	1,243	38,868	453,662	301,014
0.001	4,333	29,176	1,258	39,397	471,002	312,034

EAD, under existing without project conditions, was estimated for each damage category for all six impact areas. Results are summarized in the Table 6.2 below.

Table 6.2   Expected Annual Damages Existing Without-Project Conditions

October 2013 Prices, 3.50% Interest Rate, 50 Year Period of Analysis, Values in $ 1,000's							
Damage Category	**EAD by Economic Impact Area**						
	A	**B**	**C**	**D**	**E**	**F**	**Total**
Single Family Residential	20	282	37	1,008	987	3	2,337
Multi-Family Residential	0	453	0	178	518	0	1,149
Commercial	0	0	0	0	1,370	374	1,744
Industrial	0	0	0	0	1,792	6,071	7,863
Public	0	133	0	0	166	118	417
Automobile	2	136	4	185	251	0	578
Emergency	0	50	1	47	43	0	141
Total EAD	22	1,054	42	1,418	5,127	6,566	14,229

6.3   EAD Future Conditions

Future development was estimated out to the year 2020, representing full build-out for the Milpitas Midtown area (see Chapter 5). Future developments for this area were entered into the HEC-FDA model and EAD values were calculated for the future without project economic condition. Future hydrology was evaluated in hydrology and hydraulic studies, which concluded that the change in flow would be insignificant. Therefore, all increases in EAD under future conditions were attributable to future growth. Existing and future EAD estimates for the area of development are displayed in Table 6.3. The average annual equivalent represents the present value of future damages amortized over the 50 year period of economic analysis at the fiscal year 2014 federal discount rate of 3.50%. The increased (future at full build out) damages need to be brought back to the study year of 2013 in present value terms. Total EAD future (2020) listed in Table 6.3 is amortized over the period of analysis to arrive at average annual equivalent damages. The closer the growth is in timeline to the base year the less discounting occurs. More time between base year and most likely future the greater the discounting.

Table 6.3   Average Annual Equivalent Damages Future-Without Project Conditions

Damage Category	Expected Annual Damages			Average Annual Equivalent @ 3.50%
	Existing	Future Midtown (2020)	Total EAD Future (2020)	
Single Family Residential	987	0	987	987
Multi-Family Residential	518	157	675	645
Commercial	1,370	6	1,376	1,375
Industrial	1,792	0	1,792	1,792
Public	166	0	166	166
Automobile	251	0	251	251
Emergency	43	0	43	43
Total EAD	5,127	163	5,290	5,259

Values in $ 1,000's, October 2013 Prices, 3.50% Interest Rate, 50-Year Period of Analysis

6.4   Project Performance- Without Project Conditions

In addition to damages estimates, HEC-FDA reports flood risk in terms of project performance. Three statistical measures are provided, in accordance with ER 1105-2-101, to describe performance risk in probabilistic terms. These include annual exceedance probability, long-term risk, and assurance by events.

- Annual exceedance probability measures the chance of having a damaging flood in any given year.
- Long-term risk provides the probability of having one or more damaging floods over a period of time.
- Assurance probability indicates the chance of not having a damaging flood given a specific magnitude event.

Project performance for each impact area is displayed in Table 6.4 below.

Table 6.4   Project Performance – Without-Project Conditions

Economic Impact Area	Annual Exceedance Probability	Long-Term Risk			Assurance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2 %
A	0.0336	29%	57%	82%	99%	31%	9%	1%
B	0.1964	89%	99%	99%	42%	20%	19%	18%
C	0.2461	94%	99%	99%	35%	18%	17%	17%
D	0.1967	89%	99%	99%	42%	20%	19%	18%
E	0.0696	51%	84%	97%	68%	27%	22%	18%
F	0.0292	26%	52%	77%	88%	83%	82%	79%

CHAPTER 7: WITH-PROJECT CONDITIONS – FLOOD RISK MANAGEMENT BENEFITS

7.1   Project Benefits – The Role of Economics in the Plan Formulation Process

This section will describe how benefits of flood damage reduction of various potential alternatives were estimated. In this section, benefits and project performance outputs will be limited to flood risk management components. Non-monetary outputs such as environmental benefits, which may vary for the final array of alternatives, are not included but may factor in the plan formulation decision process.

On Berryessa Creek, flood risk management measures have been considered and screened during several phases of the study. A description of all management measures and the screening process can be found in the Main Report. In this section flood risk management benefits have been explicitly calculated for the measures that might be feasible and have been carried forward in the plan formulation. Those measures that have been screened out are not included in this appendix.

An incremental analysis examining project location and sizing was conducted with near final H&H and economics. The final changes in H&H and economics were considered and deemed non-material to the overall outcomes of the HEC-FDA model and were not updated for this report given study constraints (budget and time). Although not updated, the previous incremental results are presented in Attachment C.

7.2   With Project Conditions - Model Simulations

Benefits were determined by making changes to the HEC-FDA model that represent various with project improvements. Flood damage reduction benefits equal the difference between the without project damage conditions and the with project residual damages.

With project residual damages were simulated for the alternatives using residual floodplain depths. The reduction in project floodplains in both extent and depth from the larger without project floodplains accounts for the decrease in damages of the given alternative. Residual depths for each damage area from the four alternative with project Flo2D runs were linked to the without project inventory through modified water surface elevation (WSE) profiles within the HEC-FDA model. With the new WSEs, stage-damages functions for the alternatives were computed within HEC-FDA and overall model runs were computed for the alternatives. Alternatives 2B and 4 do not have residual floodplains at the mean 500-yr event, the upper limit of the current HEC-FDA modeling effort. Thus, the HEC-FDA model was not run for alternatives 2B and 4 as no residual damages are present.

In addition to the modifications to the floodplains, changes to the stage-discharge function and/or top of bank (top of levee failure point) were made in the HEC-FDA model to simulate project conditions for any alternative that increased channel capacity (lowering water surface at a given exceedance probability) or raised levee height (increasing non-damaging

elevation.) Details of HEC-FDA with project inputs can be found in Attachment B of this appendix.

7.3   Average Annual Equivalent Damages –With Project Conditions

HEC-FDA was run simulating with project conditions for the alternatives considered. Residual with project damages were subtracted from the without project damages to determine flood risk management benefits.   Frequency/discharge functions and stage/discharge functions were modified to simulate project conditions of the alternatives in the HEC-FDA model. All benefit values in the remaining tables of this report include average annual equivalents instead of expected annual damages. These average annual equivalent damages include future growth described in section 6.3. The future growth adds very little to the total damages (less than 1% of the total) and will not impact the plan formulation process.

7.4   Alternatives Evaluated – Flood Risk Management Benefits

Four alternatives, including the previous authorized plan, were analyzed for their flood damage reduction potential. These plans are:

1) Alternative 2A - Incised Trapezoidal Channel
2) Alternative 2B - Incised Trapezoidal Channel - Certification Level
3) Alternative 4 - Walled Trapezoidal Channel - Certification Level
4) Alternative 5 - The 1988 Authorized Plan

Damages as calculated by the HEC-FDA model for these alternatives are displayed in Table 7.1. Annual benefits in the table represent the difference between the without and with project equivalent annual damage.

Table 7.1   Annual Benefits by Alternative

Alternative	Equivalent Annual Damages		Annual Benefits
	Without Project	**With Project**	
Values in $1,000's, October 2013 Prices, 3.50% Interest Rate, 50-Year Period of Analysis			
Upstream of I-680 - Damage Areas A, B, C, & D			
Without	2,537	2,537	0
1) Alt. 5	2,537	454	2,083
2) Alt. 2A	2,537	2,537	0
3) Alt. 2B	2,537	2,537	0
4) Alt. 4	2,537	2,537	0
Downstream of I-680 - Damage Areas E & F			
Without	11,823	11,823	0
1) Alt. 5	11,823	319	11,504
2) Alt. 2A	11,823	887	10,936
3) Alt. 2B	11,823	0.00	11,823
4) Alt. 4	11,823	0.00	11,823

7.5   Probability Distribution – Damages Reduced

In accordance with ER 1105-2-101, flood damage reductions were determined as mean values and by probabilities (75%, 50%, 25%) exceeding a specified value.

Table 7.2 shows the benefits derived by each alternative in the upstream area at probabilities of 75%, 50% and 25% that benefits will exceed the indicated value. Table 7.3 shows this distribution for the downstream area. The damage reduced column represents the mean benefits for each alternative and the 75%, 50% and 25% represent the probability that the flood damage reduction benefits exceed the number in that column for that alternative. For example, Alternative 5 upstream has an average (mean) benefit of $2,083,000 but only a 50% chance that benefits will be greater than $385,000 and 75% confidence that benefits will be equal or greater than $309,000 and a 25% chance benefits will exceed $2,556,000. This range is the probability distribution of damages reduced and represents the uncertainty in the benefit estimates and incorporates all the uncertainties in hydrology, hydraulics, and economics in the HEC-FDA model. The uncertainty in damages reduced should be considered when selecting an optimal plan during the plan formulation process. Judgment should be used to determine if an alternative meets a reasonable level of confidence regarding positive net benefits and identifying if changes in net benefits from alternative to alternative are significant.

Table 7.2   Equivalent Annual Damages Reduced Upstream

Values in $1,000's, October 2013 Prices, 3.50% Interest Rate, 50 Year Period of Analysis Upstream of I-680 (Areas A, B, C, D)						
Alternative	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	2,537	2,537	0	0	0	0
1) Alt. 5	2,537	454	2,083	309	385	2,556
2) Alt. 2A[*]	2,537	2,537	0	0	0	0
3) Alt. 2B[*]	2,537	2,537	0	0	0	0
4) Alt. 4[*]	2,537	2,537	0	0	0	0
[*]These alternatives do not extend upstream into Reaches A, B, C & D						

Table 7.3   Equivalent Annual Damage Reduced Downstream

Values in $1,000's, October 2013 Prices, 3.50% Interest Rate, 50 Year Period of Analysis Downstream of I-680 (Areas E, F)						
Alternative	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	11,823	11,823	0	0	0	0
1) Alt. 5	11,823	319	11,504	3,042	3,716	8,359
2) Alt. 2A	11,823	887	10,936	2,731	3,337	8,068
3) Alt. 2B	11,823	0	11,823	11,823	11,823	11,823
4) Alt. 4	11,823	0	11,823	11,823	11,823	11,823

7.6   Project Performance – With Project Conditions

Comparisons of project performance under both with and without project conditions by economic impact area are shown in Table 7.4 to Table 7.9. The annual exceedance probability measures the chance of having a damaging flood in any given year.

The long-term risk numbers measure the chance of having one or more damaging floods over a given period of time. As shown in Table 7.5, Alternative 2B reduces the chance of getting damaged (in impact area E) over the next 30 years from 84% under the without project condition to 0% with the project.

The assurance measures the probability of not being damaged if a given event were to occur. As with the other measures, project conditions reduce the risk and larger projects have a greater reduction in risk than smaller projects. Assurance for the 1% event is often targeted to determine if a project meets Corps criteria for levee certification. It is important to note the relationship between AEP and assurance in determining project accomplishment. For example, in impact Area E (see Table 7.8) Alternative 2A only provides a 73% chance of non-damage from a 1% event. To be 90% confident that the 1% event can pass without causing damage in impact Area E, a larger project must be constructed. This often causes confusion in how to identify the performance of a project in a single traditional term such as "100-year level of protection," and as per the guidance ER 1105-2-101, the Corps has dropped all reference to describing level of protection.

Again, it is important to note that all of these statistics (AEP, long-term risk, and assurance) were calculated in HEC-FDA with uncertainties in hydrology, hydraulics and economics.

Table 7.4   Project Performance Impact Area A

Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.0336	29	57	82	99	31	9	1
1) Alt. 5	0.0052	5	12	23	99	98	83	37
2) Alt. 2A	0.0336	29	57	82	99	31	9	1
3) Alt. 2B	0.0336	29	57	82	99	31	9	1
4) Alt. 4	0.0336	29	57	82	99	31	9	1

Table 7.5   Project Performance Impact Area B

Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.1964	89	99	99	42	20	19	18
1) Alt. 5	0.2115	91	99	99	37	12	7	5
2) Alt. 2A	0.1964	89	99	99	42	20	19	18
3) Alt. 2B	0.1964	89	99	99	42	20	19	18
4) Alt. 4	0.1964	89	99	99	42	20	19	18

Table 7.6   Project Performance Impact Area C

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.2461	94	99	99	35	18	17	17
1) Alt. 5	0.3418	98	99	99	32	13	9	7
2) Alt. 2A	0.2461	94	99	99	35	18	17	17
3) Alt. 2B	0.2461	94	99	99	35	18	17	17
4) Alt. 4	0.2461	94	99	99	35	18	17	17

Table 7.7   Project Performance Impact Area D

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.1967	89	99	99	42	20	19	18
1) Alt. 5	0.2111	91	99	99	37	12	7	5
2) Alt. 2A	0.1967	89	99	99	42	20	19	18
3) Alt. 2B	0.1967	89	99	99	42	20	19	18
4) Alt. 4	0.1967	89	99	99	42	20	19	18

Table 7.8   Project Performance Impact Area E

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.0696	51	84	97	68	27	22	18
1) Alt. 5	0.0062	6	14	27	99	94	70	53
2) Alt. 2A	0.0071	7	16	30	99	83	73	61
3) Alt. 2B	0.0000	0	0	0	99	99	99	99
4) Alt. 4	0.0000	0	0	0	99	99	99	99

Table 7.9   Project Performance Impact Area F

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.0292	26	52	77	88	83	82	79
1) Alt. 5	0.0000	0	0	0	99	99	99	99
2) Alt. 2A	0.0089	9	20	36	99	86	77	64
3) Alt. 2B	0.0000	0	0	0	99	99	99	99
4) Alt. 4	0.0000	0	0	0	99	99	99	99

7.7   Other Benefits

7.7.1   Savings in Flood Insurance Administration Costs

In the past, savings in the administration costs for the National Flood Insurance Program (NFIP) were considered in the determination of NED benefits. It was based on the assumption that any alternative that removes the FEMA requirement for flood insurance could claim this benefit by reducing the number of policies required thus marginally reducing the federal administration cost of the national program. Economic Guidance Memorandum 06-04 lists the current operating cost per policy at $192 and this value was used in the benefit calculation (number of policies reduced times $192). Based on the most recent FEMA data, Milpitas has 2,493 policies in force and based on the total estimated number of structures inundated from various sources to include Berryessa and Penitencia Creeks within Milpitas, the participation rate for the area in the NFIP would be around 40%. Using this participation rate, potential benefits from savings in NFIP administration costs may be around $171,000 ($46,000 upstream of I-680 and $125,000 downstream) for any alternative that would remove all the existing structures in the Berryessa Study from the 100-year FEMA floodplain.

Recent guidance suggests that these savings should not be included in NED benefit determinations and are excluded from this analysis.

7.7.2   Advance Bridge Replacement Benefits

For many projects, relocations will result in the replacement of existing bridge facilities. Often the expected life of the replacement bridge will be greater than that of the existing structure, thereby extending the life of the bridge service being provided. Since the total cost of the new bridge is included in the first cost of the project, a credit for this extension is needed on the benefit side. A credit is also needed if any reduction in O&M costs will occur during the remaining life of the existing facility.

Calculation of replacement benefits is a function of interest rate, projected replacement bridge life, remaining bridge life and cost of replacement. In total, 4 bridges need to be replaced downstream of I-680. Following the procedures of IWR Report 88-R-2, "National Economic Development Procedures Manual – Urban Flood Damage," advance bridge replacement benefits for these bridges are shown in Table 7.10. In general, all of the bridges were constructed in the early 1970's and replacement will extend their lives beyond the study's period of analysis. The life extension within the period of analysis is estimated at 24 years. Benefits from an O&M change are not expected to occur with the bridge replacements.

Table 7.10 Advance Bridge Replacement Benefits

In Oct 2013 Prices, Using 3.50%, 50 Year Period of Analysis				
Downstream of I-680				
	Alt 2A Cost	Alts 2B & 4 Cost	Alt 2A Benefit	Alts 2B & 4 Benefit
Montague Expressway	-	$3,041,550	-	$36,300
UPRR Trestle	$1,052,200	$1,052,200	$12,600	$12,600
Los Coches Street	-	$2,147,625	-	$25,600
Calaveras Road	-	$4,674,750	-	$55,800
Alternative 5				
	Alt 5 Cost		Alt 5 Benefit	
Old Piedmont Bridge	$708,589		$8,500	
Montague Expressway	$1,040,751		$12,400	
UPRR Trestle	$1,190,522		$14,200	

7.7.3 Recreation Benefits

Improvement for flood risk management provides the opportunity for increased recreation uses in the study area. Improvement of the levees would allow for the extension of a local recreational trail. In less than one mile of the risk management improvements over 60,000 people reside, according to tract data of the 2000 Census. The estimated cost of trail construction on the improvement is $1.63 million. The amortized value of this construction is less than $76,000 or nearly $1 per person in the immediate area. The FY14 unit day value for general recreation with a zero point value is $3.84. Fewer than 60 users per day would be necessary for economic justification at this unit day value.

7.7.4 Environmental Benefits

Some of the alternatives provide incidental outputs in addition to flood damage reduction. These benefits are non-monetary and were not part of the economic analysis. Details of the Environmental Quality (EQ) account outputs of the various alternatives can be found in the Main Report.

7.7.5 Additional Flood Related Risks

In addition to the monetary losses to categories listed above, flooding from Berryessa Creek could have other damage impacts and place many public services at risk , and if reduced would provide additional non-monetary benefit. Emergency costs (about 1% of total damages) evaluated in this appendix were limited to evacuation, relocation and temporary assistance based on examples of similar flood risks found on other flood damage studies in Northern California. Administrative costs and increased public services such as police and fire were not included in these emergency cost estimates primarily due to lack of available

data regarding any comparable historical flooding within the Bay Area. Nationwide, where depth of flooding and duration of event were much greater, some studies have estimated total emergency costs (including temporary relocation, evacuation, public administration, additional emergency healthcare and increased labor) as high as 15% of the total without-project damages. While the emergency costs listed for Berryessa do not capture the total potential loss, these non-quantified losses are an incrementally-small portion of the overall losses and would not change the feasibility or formulation of any of the alternatives.

Potential traffic delays and temporary interruption in public services were also not quantified. Highway I-680 runs through the study area but would not be closed from flooding along Berryessa Creek. Minor roads within the floodplain may be closed for short durations due to flooding but alternate routes would not add significant time loss or additional resource consumption to the NED account and would not change the feasibility or formulation of any of the alternatives.

The area could suffer from significant business losses which could be included as Regional Economic Development (RED) damages in the analysis. But because most of these income losses could not be included in the NED analysis and therefore would not change the determination of the NED plan, RED benefits were not explicitly quantified for this document. Discussion of EQ, RED and Other Social Effects (OSE) accounts can be found in the Main Report.

Other non-monetary risks could also occur from a flood event but are not included in the NED evaluation. General reductions in risks to health, safety and public welfare are typically associated with flood conditions and are further reasons why flood protection serves the federal interest and the public good. Within the Berryessa Creek floodplain there are several elementary schools, two fire stations, a hospital, several medical clinics, police station and Milpitas City Hall that could lose vital public services due to flooding at least one-foot above the first floor.

CHAPTER 8: BENEFIT COST ANALYSIS – NED PLAN IDENTIFICATION

ER 1105-2-100 requires the identification of the plan that maximizes net annual benefits as the NED plan. Economic feasibility and project efficiency are determined through benefit cost analysis. For a project or increment to be feasible, benefits must exceed costs and the most efficient alternative is the one that maximizes net benefits (annual benefits minus annual costs.) The NED plan serves as the basis for federal participation. Deviations from the NED plan, as with a case of a locally preferred alternative, are measured from the NED plan for federal cost sharing allocations.

8.1   Annual Costs

With benefits calculations complete, annual costs need to be derived to complete the benefit cost analysis. Project costs were developed for the four alternatives. The project features unique to each alternative are summarized below:

- *Alternative 1 (No Action)*. Without-project condition, assuming routine maintenance.

- *Alternative 2 (Incised Trapezoidal Channel)*. Earthen trapezoidal section with varying bottom width and 2:1 side slopes. Access road intermittently along one or both banks, within channel at approximate level of 0.04 exceedance probability event, or both. Cellular bank stabilization with rip rap toe protection throughout. Levees with 2:1 to 3:1 side slopes and 12' top width or floodwalls as required.

- *Alternative 4 (Walled Trapezoidal Channel)*. 10' bottom width earthen low-flow channel with 3:1 side slopes, 3' deep. Two vegetated floodplain benches bounded by vertical concrete floodwalls, 32' bench width on the left bank, and 10' width on the right bank. Access road location varies. Wall extensions as required to contain flows.

- *Alternative 5 (Authorized Plan)*. Sediment basin upstream of Old Piedmont, earthen levees in the Greenbelt, concrete trapezoidal channel downstream of I-680.

Appendix B Part IV, Design and Cost Alternatives reports the total construction costs for each alternative as shown in Table 8.1. (The costs shown in Table 8.1 were estimated as part of the alternatives screening process that occurred in the 2011/2012 timeframe. A more current and detailed MCACES cost estimate of the Recommended Plan was completed in 2013 and can be found in the Cost Engineering appendix.)

Table 8.1   Summary of Construction Cost by Alternative

October 2012 Price Level, 3.75% Interest Rate, 50 Year Period of Analysis				
Item	Alt - 2A	Alt - 2B	Alt - 4	Alt - 5
Total Construction Cost	$11,215,000	$36,224,000	$63,371,000	$34,881,000
Design Phase/PED	$1,698,000	$4,773,000	$8,381,000	$4,745,000
Construction Mgt-Inspection & Admin/SI/SA	$1,066,000	$3,046,000	$5,348,000	$3,027,000
LERRD Acquisition Costs	$9,828,000	$15,137,000	$14,965,000	$46,190,000
LERRD Administrative Costs	$1,250,000	$1,250,000	$1,220,000	$2,080,000
Recreation Facilities	$1,626,000	$1,626,000	$1,626,000	$0
Total First Cost	$26,683,000	$62,056,000	$94,911,000	$90,923,000
Interest During Construction (IDC)	$1,001,000	$2,327,000	$3,559,000	$3,410,000
Total Project Economic Cost	$27,684,000	$64,383,000	$98,470,000	$94,333,000
Annualized Project Economic Cost	$1,234,000	$2,870,000	$4,389,000	$4,205,000
Annual OMRR&R	$63,000	$79,000	$89,000	$128,000
Total Annual Economic Cost	$1,297,000	$2,949,000	$4,478,000	$4,333,000

Interest during construction (IDC) for these alternatives is based on a 2 year midlife full expenditure approach.

8.2   Net Annual Benefits

Economic efficiency is measured based on the maximization of project net benefits. Net benefits are determined as the difference between the annual benefits and the annual costs of an alternative. Table 8.2 shows equivalent damage reductions and Table 8.3 shows net benefits and the benefit-cost ratio for each alternative. **The tables below show the results based on the prices and discount rate prevailing at the time of the screening of alternatives, which in this case are October 2013 prices and a 3.75% discount rate, respectively. Attachment E displays the net benefit analysis using current cost estimates and the current federal discount rate of 3.50%.**

Table 8.2   Equivalent Annual Damage Reduced

Values in $1000s, October 2013 Prices, 3.75% Interest Rate, 50 Year Period of Analysis						
	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Alt 1: No Action	14,360	14,360	0	-	-	-
Alt 2A/downstream	11,824	887	10,937	2,731	3,337	8,068
Alt 2B/downstream	11,824	0	11,824	n/a	n/a	n/a
Alt 4/downstream	11,824	0	11,824	n/a	n/a	n/a
Alt 5: Authorized Plan	14,360	773	13,587	3,351	4,100	10,915

Table 8.3   Annual Benefits and Costs by Alternative

Values are in October 2013 Prices in $1000s Based on a 50-year Period of Analysis (Discounted using 3.75 % interest rate)				
Item	Alt 2A	Alt 2B	Alt 4	Alt 5
Total Project Cost	27,684	64,383	98,470	96,020
Annual Benefits Flood Damage Reduction[2]	10,937	11,824	11,824	13,587
Savings in NFIP Administration Costs	0	0	0	0
Advanced Bridge Replacement	13	130	130	35
Total Annual Benefits	10,950	11,954	11,954	13,622
Total Annual Costs	1,297	2,949	4,478	4,333
Net Benefits	9,653	9,005	7,476	9,289
B/C Ratio	8.4	4.1	2.7	3.1
Alternative 2A under OMB's 7% rate				
Annual Benefits	10,944			
Annual Costs	2,132			
Net Annual Benefits	8,812			
B/C Ratio	5.1			

The alternative that maximizes net annual benefits is Alternative 2A and as such is the NED plan. Alternative 2A is a Moderate Protection plan that includes channel modifications in addition to modifications and/or complete replacements at bridge and culvert crossings with the top of bank or top of levee/floodwall elevations set at the water surface level of the 0.01

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[2] Benefits include future development flood damage reduction benefits.

exceedance probability event (100-year). The modifications or retrofits include shoring and transition structures, headwall extensions with transition structure, and bridge replacement (UPRR Trestle). Modifications within channel reaches include channel widening, bank stabilization, and levee/floodwall construction.

Upon identification of the NED Plan and the determination to carry it forward as the Recommended Plan, a more detailed, updated cost estimate was completed for Alternative 2A using the current federal discount rate of 3.50%. This estimate was incorporated into revised net benefit and BCR analyses for Alternative 2A and is shown below in Tables 8.4 and 8.5 as well as in Attachment E. The net benefits and BCR for Alternative 2A using the updated costs and current discount rate are approximately $9.7 million and 8.6, respectively.

Table 8.4: Summary of Costs for the Recommended Plan (Alternative 2A)

October 2013 Price Level, 3.50% Discount Rate, 50-Year Period of Analysis, in $1,000s	
Item	**Alternative 2A**
Total Construction Cost	11,284
Design Phase/PED	1,716
Construction Mgt-Inspection & Admin/SI/SA	1,122
LERRD	13,078
Total First Cost	27,200
Interest During Construction (IDC)	1,020
Total Project Economic Cost	28,220
Annualized Project Economic Cost	1,203
Annual OMRR&R	63
Total Annual Economic Cost	1,266

Table 8.5: Updated Net Benefit and Benefit-to-Cost Analyses for the Recommended Plan (Alternative 2A)

October 2013 Price Level, 3.50% Discount Rate, 50-Year Period of Analysis, in $1,000s	
Item	**Alternative 2A**
Total Project Cost	28,220
Annual Benefits (FRM)	10,937
Savings in NFIP Administrative Costs	0
Advanced Bridge Replacement Benefits	13
Total Annual Benefits	10,950
Total Annual Costs	1,266
Net Benefits	**9,684**
Benefit-to-Cost Ratio (BCR)	**8.6**
Alternative 2A Evaluated @ OMB's 7% Discount Rate	
Total Annual Benefits	10,944
Total Annual Costs	2,109
Net Benefits	**8,835**
BCR	**5.2**

ATTACHMENT A: H&H RELATIONSHIPS WITHOUT-PROJECT USED IN THE HEC-FDA MODEL

Along with the economic stage-damage functions, hydrologic and hydraulic functions are part of the flood damage analysis model. The probability-discharge, stage-discharge and interior-exterior stage relationships were provided and developed by the H&H members of the Berryessa study team. These relationships in Attachment A represent without project conditions.

A.1   Probability Curves

For Areas A-F, probability- discharge curves were developed for the HEC-FDA model. The discharge values in these relationships represent total flows both in channel and in the floodplain. Tables A1-A to A1-F display the probability functions for each damage area in the study.

Table A1-A: Probability-Discharge Area A

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	71
0.500	240	188	212	271	307
0.200	420	304	357	494	580
0.100	560	371	456	688	846
0.040	830	515	654	1054	1338
0.020	1090	642	837	1420	1850
0.010	1430	798	1068	1915	2564
0.004	1904	1000	1380	2628	3627
0.002	2142	1096	1532	2995	4186
0.001	2392	1194	1690	3385	4790

Table A1-B: Probability-Discharge Area B

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	72
0.500	252	196	222	285	323
0.200	444	318	376	525	620
0.100	603	399	491	741	911
0.040	886	551	698	1124	1426
0.020	1118	666	863	1449	1878
0.010	1180	695	906	1537	2003
0.004	1238	722	946	1620	2121
0.002	1252	729	955	1641	2150
0.001	1266	735	965	1660	2178

Table A1-C: Probability-Discharge Area C

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	72
0.500	252	196	222	285	323
0.200	444	318	376	525	620
0.100	603	399	491	741	911
0.040	886	551	698	1124	1426
0.020	1118	666	863	1449	1878
0.010	1180	695	906	1537	2003
0.004	1238	722	946	1620	2121
0.002	1252	729	955	1641	2150
0.001	1266	735	965	1660	2178

Table A1-D: Probability-Discharge Area D

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	72
0.500	252	196	222	285	323
0.200	444	318	376	525	620
0.100	603	399	491	741	911
0.040	886	551	698	1124	1426
0.020	1118	666	863	1449	1878
0.010	1180	695	906	1537	2003
0.004	1238	722	946	1620	2121
0.002	1252	729	955	1641	2150
0.001	1266	735	965	1660	2178

Table A1-E: Probability-Discharge Area E

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	200	164	181	221	243
0.500	488	420	453	526	566
0.200	698	533	610	798	913
0.100	953	691	812	1119	1314
0.040	1145	799	956	1370	1640
0.020	1398	931	1141	1712	2098
0.010	1544	1004	1245	1915	2375
0.004	1650	1055	1320	2063	2580
0.002	1771	1112	1403	2234	2818
0.001	1892	1168	1487	2407	3063

Table A1-F: Probability-Discharge Area F

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	100	63	80	126	158
0.500	678	550	611	752	834
0.200	924	705	807	1057	1210
0.100	1300	962	1118	1512	1758
0.040	1521	1105	1296	1783	2091
0.020	1550	1124	1320	1819	2136
0.010	1612	1164	1369	1896	2232
0.004	1741	1246	1473	2058	2434
0.002	1924	1359	1617	2289	2723
0.001	2113	1475	1765	2529	3027

A.2   Rating Curves- Stage vs. Discharge

The following Tables A3-A to A3-E show the stage-discharge functions with uncertainty used in the HEC-FDA model. Stage represents elevation in channel and discharge is flow in channel. Curves were developed for Areas A-F.

Table A3-A: Stage-Discharge Area A

Discharge in Channel (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	207.90	0.000
240	213.70	0.426
420	214.28	0.469
560	215.12	0.530
830	216.88	0.660
1090	219.26	0.835
1430	220.15	0.900
1820	221.39	0.900
2142	222.31	0.900

Table A3-B: Stage-Discharge Area B

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	141.40	0.000
252	146.06	0.662
444	146.79	0.765
603	147.06	0.803
886	147.49	0.865
1118	147.69	0.896
1180	147.74	0.900
1233	147.81	0.900
1252	147.83	0.900

Table A3-C: Stage-Discharge Area C

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	140.75	0.000
252	145.40	0.679
444	146.09	0.780
603	146.34	0.817
886	146.70	0.869
1118	146.89	0.897
1180	146.91	0.900
1233	146.93	0.900
1252	146.94	0.900

Table A3-D: Stage-Discharge Area D

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	141.40	0.000
252	146.06	0.662
444	146.79	0.765
603	147.06	0.803
886	147.49	0.865
1118	147.69	0.896
1180	147.74	0.900
1233	147.81	0.900
1252	147.83	0.900

Table A3-E: Stage-Discharge Area E

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	57.01	0.000
487.7	61.63	0.529
697.8	62.59	0.639
953.3	63.58	0.753
1144.7	64.50	0.858
1397.8	64.71	0.882
1544.2	64.86	0.900
1611.1	65.01	0.900
1770.5	65.07	0.900

Table A3-F: Stage-Discharge Area F

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	31.10	0.000
677.5	36.80	0.712
923.5	37.76	0.831
1300.4	37.86	0.844
1520.5	38.13	0.878
1549.7	38.21	0.888
1611.5	38.31	0.900
1683.4	38.33	0.900
1923.9	38.35	0.900

ATTACHMENT B: HEC-FDA MODEL WITH-PROJECT MODIFIED RELATIONSHIPS

Project conditions were simulated in the model by making changes to the base relationships. For all alternatives, the stage-damage functions were modified to reflect depth of flooding under various project conditions. The exceedance probability – damage function from HEC-FDA for each alternative are shown in Tables B1-A to B1-F.

Table B1-A: Damage Area A - Mean Damages in $1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	0	0	0	0	0
.04	0	0	0	0	0
.02	171	0	171	171	171
.01	837	0	837	837	837
.004	1,447	0	1,447	1,447	1,447
.002	2,897	931	2,897	2,897	2,897

Table B1-B: Damage Area B - Mean Damages in $1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	221	0	221	221	221
.04	15,046	15	15,046	15,046	15,046
.02	22,292	4,296	22,292	22,292	22,292
.01	25,916	11,658	25,916	25,916	25,916
.004	28,089	15,545	28,089	28,089	28,089
.002	28,814	16,841	28,814	28,814	28,814

Table B1-C: Damage Area C - Mean Damages in $1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	11	0	11	11	11
.04	659	35	659	659	659
.02	967	403	967	967	967
.01	1,120	588	1,120	1,120	1,120
.004	1,212	699	1,212	1,212	1,212
.002	1,243	755	1,243	1,243	1,243

Table B1-D: Damage Area D - Mean Damages in $1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	116	0	116	116	116
.04	18,765	712	18,765	18,765	18,765
.02	29,346	4,625	29,346	29,346	29,346
.01	34,636	11,810	34,636	34,636	34,636
.004	37,810	15,990	37,810	37,810	37,810
.002	38,868	17,384	38,868	38,868	38,868

Table B1-E: Damage Area E - Mean Damages in $1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	0	0	0	0	0
.04	15,843	0	0	0	0
.02	141,546	0	0	0	0
.01	314,944	0	0	0	0
.004	418,983	26,761	22,016	0	0
.002	453,662	99,304	40,833	0	0

Table B1-F: Damage Area F - Mean Damages in $1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	0	0	0	0	0
.04	0	0	0	0	0
.02	102,657	0	0	0	0
.01	212,855	0	0	0	0
.004	278,974	0	127,319	0	0
.002	301,014	0	176,285	0	0

For some alternatives, top of bank/levee, stage-discharge, and inflow vs. outflow were modified to reflect channel and bank improvements. These modifications were incorporated into the HEC-FDA where applicable. Tables B2-A to F show the changes in flow and stage for each alternative. Table B3 lists the top of levee/failure damage elevation for each area and alternative.

Table B2-A: Total Discharge - Stage in Channel Area A

Without Project		Alt. 5		Alt. 2A		Alts. 2B & 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
240	213.7	243	211.19	240	213.7	240	213.7
420	214.28	420	212.66	420	214.28	420	214.28
560	215.12	564	213.80	560	215.12	560	215.12
830	216.88	830	215.24	830	216.88	830	216.88
1,090	219.26	1,096	216.70	1,090	219.26	1,090	219.26
1,430	220.15	1,427	218.51	1,430	220.15	1,430	220.15
1,820	221.39	1,820	219.38	1,820	221.39	1,820	221.39
2,130	222.31	2,130	223.14	2,130	222.31	2,130	222.31

Table B2-B: Total Discharge - Stage in Channel Areas B & D

Without Project		Alt. 5		Alt. 2A		Alts. 2B & 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
252	146.06	261	146.09	252	146.06	252	146.06
444	146.79	452	146.88	444	146.79	444	146.79
603	147.06	595	147.17	603	147.06	603	147.06
886	147.49	870	147.61	886	147.49	886	147.49
1118	147.69	1160	147.96	1118	147.69	1118	147.69
1180	147.74	1521	148.33	1180	147.74	1180	147.74
1233	147.81	1755	148.55	1233	147.81	1233	147.81
1252	147.83	1787	148.57	1252	147.83	1252	147.83

Table B2-C: Total Discharge - Stage in Channel Area C

Without Project		Alt. 5		Alt. 2A		Alts. 2B & 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
252	145.40	261	146.09	252	145.40	252	145.40
444	146.09	452	146.10	444	146.09	444	146.09
603	146.34	595	146.36	603	146.34	603	146.34
886	146.70	870	146.78	886	146.70	886	146.70
1118	146.89	1160	147.02	1118	146.89	1118	146.89
1180	146.91	1521	147.27	1180	146.91	1180	146.91
1233	146.93	1755	147.42	1233	146.93	1233	146.93
1252	146.94	1787	147.44	1252	146.94	1252	146.94

Table B2-D: Total Discharge - Stage in Channel Area E

Without Project		Alt. 5		Alt. 2A		Alt. 2B		Alt. 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
487.7	61.63	481.2	57.67	487.7	58.20	487.80	58.97	489.50	58.42
697.8	62.59	676.6	59.28	697.8	59.23	698.60	59.86	699.70	58.94
953.3	63.58	848.6	60.06	953.3	60.11	953.40	60.46	953.40	59.47
1144.7	64.50	1207.9	62.06	1144.7	61.07	1144.70	60.86	1144.70	59.98
1397.8	64.71	1525.6	63.12	1397.8	61.59	1399.50	61.39	1400.80	60.36
1544.2	64.86	1987.7	64.62	1544.2	64.15	1544.20	61.70	1544.20	61.00
1611.1	65.01	2310.7	65.32	1611.1	65.28	1611.20	62.49	1611.30	61.97
1770.5	65.07	2358.6	65.50	1770.5	65.48	1770.70	62.95	1770.70	62.55

Table B2-E: Total Discharge - Stage in Channel Area F

Without Project		Alt. 5		Alt. 2A		Alt. 2B		Alt. 4	
Total Discharge (inflow)	Stage in Channel (Feet)	Total Discharge (inflow)	Stage in Channel (Feet)	Total Discharge (inflow)	Stage in Channel (Feet)	Total Discharge (inflow)	Stage in Channel (Feet)	Total Discharge (inflow)	Stage in Channel (Feet)
677.5	36.80	685.4	34.14	676.7	35.01	676.40	34.84	674.00	36.52
923.5	37.76	1016.5	34.94	1020.0	35.94	1019.90	35.84	1016.10	37.37
1300.4	37.86	1192.6	35.32	1306.8	36.59	1312.00	36.53	1307.40	37.97
1520.5	38.13	1685.8	36.29	1690.6	37.53	1696.60	37.45	1686.20	38.91
1549.7	38.21	1963.6	36.78	1895.8	37.86	1902.30	37.83	1886.60	39.36
1611.5	38.31	2340.8	37.35	2189.7	38.20	2206.10	38.19	2194.60	39.83
1683.4	38.33	2623.3	37.75	2586.9	38.56	2658.80	38.65	2638.10	40.43
1923.9	38.35	2826.1	37.99	2861.1	38.73	2975.50	38.93	2946.70	40.80

Table B3: Top of Levee Elevations

Damage Failure Points by Alternatives and Areas

Damage Area	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
A	217.90	220.50	217.90	217.90	217.90
B	146.90	146.90	146.90	146.90	146.90
C	146.00	146.00	146.00	146.00	146.00
D	146.90	146.90	146.90	146.90	146.90
E	64.07	65.15	65.27	65.50	66.01
F	39.00	40.42	38.88	41.35	43.80

ATTACHMENT C: INCREMENTAL ANALYSIS (PRELIMINARY F4A REPORT JUNE 2006)

C.1   Incremental Alternatives (Preliminary)

Benefits were calculated on incremental basis. The first was to determine feasibility of separable geographic areas: downstream of I-680 and upstream of I-680. The second was to determine optimal project sizing.

The goal of this incremental benefit analysis is to answer two simple questions: WHERE and HOW BIG? Is there a federal interest to construct a continuous project providing flood damage reduction to all impact areas? And what is the optimal size of project for these areas? For this analysis, benefits were evaluated for basic trapezoidal earthen channel improvements with varying capacity to reflect different sizing. Additional improvements such as levees and bridge improvements were added to some reaches or creek sections of the channel when needed to allow for full target conveyance (a more complete description of improvements required to meet conveyance can be found in Appendix B: Engineering Part IV Design and Cost of Alternatives.)

C.2   Project Conditions- Model Simulations

Benefits were determined by making changes to the economic model that represent various with project improvements. Flood damage reduction benefits equal the difference between the without project damage conditions and the with project residual damages.

With project residual damages were simulated for the incremental alternatives using residual floodplain depths. The reduction in project floodplains in both extent and depth from the larger without project floodplains accounts for the decrease in damages of the given alternative. Residual depths from five different sized with project Flo2D (see Appendix B Part I and II) runs for each damage area were linked to the without project inventory and the @RISK model was rerun to determine mean and standard deviation for the residual damage. From the @RISK output, with project stage-damage curves were generated for entry in the HEC-FDA model.

In addition to the modifications to the floodplains, changes to the stage-discharge function and/or top of bank (top of levee failure point) were made in the HEC-FDA model to simulate project conditions for any alternative or incremental measure that increased channel capacity (lowering water surface at a given exceedance probability) or raised levee height (increasing non-damaging elevation.) Details of HEC-FDA with project inputs can be found in Attachment B of this appendix.

C.3   Average Annual Equivalent Damages –With Project Conditions

For the preliminary alternatives considered, HEC-FDA was run simulating with project conditions. The residual with project damages were subtracted from the without project damages to determine flood damage reduction benefits. Total discharge- flow in channel, stage-discharge, and interior-exterior stage relationships were modified to simulate these project conditions in the HEC-FDA model. All benefit values in the remaining tables of this report included average annual equivalents instead of expected annual damages. These average annual equivalent damages include future growth described in section 6.3. The future growth adds very little to the total damages (less than 1% of the total) and will not impact the plan formulation process.

C.4   Alternatives Evaluated – Incremental Benefit Analysis

Incremental benefit evaluation to determine the optimal NED plan was formulated based on reasonable separable project features and sizing. The damage areas upstream of I-680 and downstream of I-680 are hydraulically independent and were separated into two groups:

> Upstream – Areas A, B, C, & D
> Downstream – Areas E & F

See Figure 1 for location of each impact area. Features were identified and categorized based on potential flood reduction and magnitude of cost. Exceedance probability of breakout by location, constriction, component costs and project performance goals were all used to select reasonable increments for benefit evaluation. Details of the project components and selection can be found in the main report. After preliminary iterations, with project residual damages were modeled for the following increments:

1) Project designed to pass flows (without uncertainty) equivalent to a minimum of 0.03 exceedance probability.
2) Project designed to pass flows (without uncertainty) equivalent to a minimum of 0.02 exceedance probability.
3) Project designed to pass flows (without uncertainty) equivalent to a minimum of 0.01 exceedance probability.
4) Additional components to the 0.01 project design to meet project performance criteria of 90% Conditional Non-Exceedance Probability of the 0.01 exceedance probability event.
5) Additional components to the 0.01 project design to meet project performance criteria of 95% Conditional Non-Exceedance Probability of the 0.01 exceedance probability event.

In total, ten project increments were run (five sizes each for the two separable areas) in HEC-FDA with the residual damages and benefits displayed in Table 17. Annual benefits in the table, represent the difference between the without and with project equivalent annual damages for each alternative row. The incremental benefits show the difference between

benefits from one incremental alternative to the next larger increment. It should be noted that alternatives beyond the 0.01 exceedance probability provide diminishing returns. The greatest benefit increments are realized as the more frequent floods are reduced. The channel improvements not only eliminate damages from the more frequent events but also reduce the magnitude of damage for the larger residual events.

Table 17
Annual Benefits by Increment
Values in $1,000's, October 2005 Prices,
5 3/8 % Interest Rate, 50 Year Period of Analysis

Increment/ Alternative	Equivalent Annual Damages		Annual Benefits	Incremental Benefits
	Without Project	With Project		
Upstream of I-680 – Damage Areas A, B, C, D				
Without	581	581	0	0
1) Pass 0.03 exceedance probability	581	326	255	255
2) Pass 0.02 exceedance probability	581	280	301	46
3) Pass 0.01 exceedance probability	581	65	516	215
4) Meet 90% CNP	581	14	567	51
5) Meet 95% CNP	581	10	571	4
Downstream of I-680 – Damage Areas E, F				
Without	9,863	9,863	0	0
1) Pass 0.03 exceedance probability	9,863	5,643	4,220	4220
2) Pass 0.02 exceedance probability	9,863	3,981	5,882	1662
3) Pass 0.01 exceedance probability	9,863	530	9,333	3451
4) Meet 90% CNP	9,863	160	9,703	370
5) Meet 95% CNP	9,863	60	9,803	100

C.5   Probability Distribution – Damages Reduced

In accordance with ER 1105-2-101, flood damages reduced were determined as mean values and by probability exceeded. Table 18 shows benefits for each upstream increment for the 75%, 50% and 25% probability that benefit exceeds indicated value. Table 19 shows this probability distribution for the downstream increments. The damage reduced column represents the mean benefits for each increment and the 75%, 50% and 25% represent the probability that the flood damage reduction benefits exceed the number in that column for that increment. For example, the upstream increment designed to pass the 0.01 exceedance probability event has an average (mean) benefit of $516,000 but only a 50% chance that benefits will be greater than $435,000 and 75% confidence that benefits will be equal or greater than $258,000 and a 25% chance benefits will exceed $681,000. This range is the probability distribution of damages reduced and represents the uncertainty in the benefit estimates and incorporates all the uncertainties in hydrology, hydraulics, and economics in the HEC-FDA model. The uncertainty in damages reduced should be considered when selecting an optimal plan during the plan formulation process. Judgment should be used to determine if an alternative meets a reasonable level of confidence regarding positive net benefits and identifying if changes in net benefits from alternative to alternative are significant.

Table 18
Equivalent Annual Damage Reduced
Values in $ 1,000's, October 2005 Prices
Upstream of I-680 (Areas A, B, C, D)

Increment	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	581	581	0	0	0	0
1) Pass 0.03 exceedance probability	581	326	255	173	250	320
2) Pass 0.02 exceedance probability	581	280	301	199	291	378
3) Pass 0.01 exceedance probability	581	65	516	258	435	681
4) Meet 90% CNP	581	14	567	268	465	752
5) Meet 95% CNP	581	10	571	268	468	760

Table 19
Equivalent Annual Damage Reduced
Values in $ 1,000's, October 2005 Prices
Downstream of I-680 (Areas E, F)

Increment	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	9,863	9,863	0	0	0	0
1) Pass 0.03 exceedance probability	9,863	5,643	4,220	2,760	3,771	5,254
2) Pass 0.02 exceedance probability	9,863	3,981	5,882	3,707	5,262	7,570
3) Pass 0.01 exceedance probability	9,863	530	9,333	5,170	7,924	12,185
4) Meet 90% CNP	9,863	160	9,703	5,292	8,185	12,715
5) Meet 95% CNP	9,863	60	9,803	5,316	8,262	12,862

C.6   Project Performance – With Project Conditions

The following Tables 20-25 show a comparison of project performance under both with and without project conditions by economic impact area (see Section 6.4 for overview of terms). The annual exceedance probability measures the chance of having a damaging flood in any given year. As larger increments are analyzed, the annual exceedance probability (AEP) drops (for example-impact area A goes from a 1 in 25 chance without project to a 1 in 500 chance for the largest project) representing a decrease in flood risk.

The long-term risk numbers measure the chance of having one or more damaging flood over a giver period of time. As shown in Table 21, building a project that will pass the 0.01 exceedance probability event reduces the chance of getting damaged (in impact area B) over the next 25 years from 94% under the without project condition to only 23 % with the project.

The conditional non-exceedance probability (CNP) measures the probability of not being damaged if a given event were to occur. As with the other measures, project conditions reduce the risk and larger projects have a greater reduction in risk than small projects. The CNP for the 1% event is often targeted to determine if a project meets Corps criteria for levee certification. It is important to note the relationship between AEP and CNP in determining project accomplishment. For example, in impact area d (see Table 23) the project that has an AEP of 0.01 (1%) only provides a 52% chance of non-damage from a 1% event. To be 95%

confident that the 1% event can pass without causing damage in impact area D, a much larger project with AEP of 0.002 (0.2%) must be constructed. This often causes confusion in how to identify the performance of a project in a single traditional term such as "100-year level of protection," and as per the guidance ER 1105-2-101, the Corps has dropped all reference to describing level of protection.

Again, it is important to note, that all of these statistics (AEP, long-term risk, and CNP) were calculated in HEC-FDA with uncertainties in hydrology, hydraulics and economics.

Table 20
Project Performance With and Without Project Conditions
Impact Area A

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.040	33%	64%	87%	97%	23%	6%	1%
1) Pass 0.03 exceedance probability	0.040	33%	64%	87%	97%	23%	6%	1%
2) Pass 0.02 exceedance probability	0.024	21%	45%	70%	100%	51%	20%	2%
3) Pass 0.01 exceedance probability	0.011	11%	24%	43%	100%	86%	56%	15%
4) Meet 90% CNP	0.004	4%	9%	17%	100%	99%	90%	58%
5) Meet 95% CNP	0.002	2%	6%	11%	100%	100%	95%	79%

Table 21
Project Performance With and Without Project Conditions
Impact Area B

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.108	68%	94%	99%	51%	1%	0%	0%
1) Pass 0.03 exceedance probability	0.035	30%	59%	83%	98%	30%	9%	1%
2) Pass 0.02 exceedance probability	0.026	23%	48%	73%	99%	46%	17%	2%
3) Pass 0.01 exceedance probability	0.010	10%	23%	40%	100%	84%	52%	12%
4) Meet 90% CNP	0.004	4%	10%	18%	100%	99%	90%	49%
5) Meet 95% CNP	0.002	2%	6%	12%	100%	100%	95%	66%

Table 22
Project Performance With and Without Project Conditions
Impact Area C

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.047	38%	70%	91%	95%	14%	3%	0%
1) Pass 0.03 exceedance probability	0.035	30%	59%	83%	99%	26%	7%	1%
2) Pass 0.02 exceedance probability	0.020	18%	40%	64%	100%	58%	28%	8%
3) Pass 0.01 exceedance probability	0.013	12%	28%	47%	100%	79%	49%	15%
4) Meet 90% CNP	0.004	4%	9%	16%	100%	99%	90%	55%
5) Meet 95% CNP	0.002	2%	5%	9%	100%	100%	95%	73%

Table 23
Project Performance With and Without Project Conditions
Impact Area D

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.107	68%	94%	99%	51%	1%	0%	0%
1) Pass 0.03 exceedance probability	0.034	30%	58%	83%	98%	30%	9%	1%
2) Pass 0.02 exceedance probability	0.026	23%	48%	73%	99%	46%	17%	2%
3) Pass 0.01 exceedance probability	0.010	10%	22%	40%	100%	84%	52%	12%
4) Meet 90% CNP	0.004	4%	10%	18%	100%	99%	90%	49%
5) Meet 95% CNP	0.001	1%	3%	6%	100%	100%	95%	66%

Table 24
Project Performance With and Without Project Conditions
Impact Area E

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.117	71%	96%	99%	52%	1%	0%	0%
a) Pass 0.03 exceedance probability	0.034	30%	58%	83%	99%	27%	3%	0%
b) Pass 0.02 exceedance probability	0.022	20%	43%	68%	100%	57%	14%	1%
c) Pass 0.01 exceedance probability	0.010	9%	22%	39%	100%	95%	53%	6%
d) Meet 90% CNP	0.004	4%	9%	17%	100%	100%	90%	30%
e) Meet 95% CNP	0.002	2%	5%	10%	100%	100%	95%	42%

Table 25
Project Performance With and Without Conditions
Impact Area F

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2 %
Without	0.133	76%	97%	99%	43%	0%	0%	0%
a) Pass 0.03 exceedance probability	0.034	29%	58%	82%	98%	40%	17%	2%
b) Pass 0.02 exceedance probability	0.030	26%	53%	78%	99%	46%	21%	3%
c) Pass 0.01 exceedance probability	0.008	8%	18%	33%	100%	90%	56%	12%
d) Meet 90% CNP	0.002	2%	5%	10%	100%	99%	90%	43%
e) Meet 95% CNP	0.001	1%	3%	5%	100%	100%	95%	68%

ATTACHMENT D: VERIFICATION OF INCREASING NET BENEFITS

D.1   Analysis of Smaller Version of Identified NED Alternative – Alternative 2Aa

The main economic report's analysis identified Alternative 2A as the NED plan. To confirm Alternative 2A's selection, an additional analysis on optimization was conducted to ensure increasing net benefits by analyzing a smaller version (Alternative 2Aa) of the plan. The analysis of Alternative 2Aa followed the same procedures as with the other alternatives analyzed during this study. Engineering runs of hydrology & hydraulics were computed for this alternative and were compiled with the economic data within HEC-FDA.   The results of the HEC-FDA model are shown in the table below.

Table 1
Equivalent Annual Damages – Alternatives 2A & 2Aa

Alternative	Values in $1,000's, October 2012 Prices, 4% Interest Rate, 50-Year Period of Analysis		Annual Benefits
	Equivalent Annual Damages		
	Without Project	**With Project**	
Upstream of I-680 - Damage Areas A, B, C, & D			
Without	2,536.73	2,536.73	0
Alt. 2A	2,536.73	2,536.73	0
Alt. 2Aa	2,536.73	2,536.73	0
Downstream of I-680 - Damage Areas E & F			
Without	11,823.26	11,823.26	0
Alt. 2A	11,823.26	886.62	10,936.64
Alt. 2Aa	11,823.26	2,082.29	9,740.97

A similar construction cost estimate to the others was prepared for Alternative 2Aa and is displayed below.

Table 2
Construction Cost Estimate – Alternatives 2A & 2Aa

October 2011 Price Level, 4% Interest Rate, 50 Year period of Analysis		
Item	**Alt - 2A**	**Alt - 2Aa**
Total Construction Cost	$9,215,695	$7,576,284
Contingency	$2,764,708	$2,272,885
Design Phase/PED	$1,382,354	$1,136,443
Construction Mgt-Inspection & Admin/SI/SA	$737,256	$606,103
LERRD Acquisition Costs	$9,825,000	$8,351,250
LERRD Investigations cost	$200,000	$200,000
Total First Cost	$24,125,013	$20,142,964
Interest During Construction	$984,301	$821,833
Total Project Economic Cost	$25,109,313	$20,964,797
Annualized Project Economic Cost	$1,168,844	$975,916
Annual OMRR&R	$63,071	$53,610
Total Annual Economic Cost	$1,231,914	$1,029,526

The results of the above costs and benefits indicate Alternative 2A produces greater net benefits than Alternative 2Aa.

Table 3
Annual Benefits and Costs

Values are in October 2011 Prices in $1000s Based on a 50-year Period of Analysis (Discounted using 4 % interest rate)		
Item	**Alt 2A**	**Alt 2Aa**
Total Cost	$25,109	20,965
Annual Benefits Flood Damage Reduction	$10,937	9,741
Savings in NFIP Administration Costs	$0	0
Advanced Bridge Replacement	$13	0
Total Annual Benefits	$10,950	$9,741
Annual Costs	$1,232	$1,030
Net Benefits	$9,718	$8,711
B/C Ratio	8.89	9.46

December 1, 2013
Attachment E

ATTACHMENT E: Updated Costs of Recommended Plan (Alternative 2A)

Costs for the Recommended Plan (Alternative 2A) have been updated since the initial alternatives screening analysis was completed (and as presented in the previous chapters). Table 1 shows the updated costs for Alternative 2A; Table 2 displays the updated net benefit and benefit-to-cost analyses using the most current costs from Table 1.

Table 1: Summary of Costs for the Recommended Plan (Alternative 2A)

October 2013 Price Level, 3.50% Discount Rate, 50-Year Period of Analysis, in $1,000s	
Item	**Alternative 2A**
Total Construction Cost	11,284
Design Phase/PED	1,716
Construction Mgt-Inspection & Admin/SI/SA	1,122
LERRD	13,078
Total First Cost	27,200
Interest During Construction (IDC)	1,020
Total Project Economic Cost	28,220
Annualized Project Economic Cost	1,203
Annual OMRR&R	63
Total Annual Economic Cost	1,266

Table 2: Updated Net Benefit and Benefit-to-Cost Analyses for the Recommended Plan (Alternative 2A)

October 2013 Price Level, 3.50% Discount Rate, 50-Year Period of Analysis, in $1,000s	
Item	**Alternative 2A**
Total Project Cost	28,220
Annual Benefits (FRM)	10,937
Savings in NFIP Administrative Costs	0
Advanced Bridge Replacement Benefits	13
Total Annual Benefits	10,950
Total Annual Costs	1,266
Net Benefits	**9,684**
Benefit-to-Cost Ratio (BCR)	**8.6**
Alternative 2A Evaluated @ OMB's 7% Discount Rate	
Total Annual Benefits	10,944
Total Annual Costs	2,109
Net Benefits	**8,835**
BCR	**5.2**

MEMORANDUM FOR FILE

SUBJECT: **Berryessa Creek General Reevaluation Report (GRR), Economic Appendix, Resolution to Recommendations Provided by the Independent External Peer Review (IEPR) Economics Panel Member**

The purpose of this memorandum for file (MFF) is to provide additional information and analysis regarding the economics as outlined in the responses to the IEPR comments/recommendations. Most of the recommendations were adopted and addressed through the actual responses to the comments instead of being incorporated into the original Economic Appendix. The economics-related IEPR comments/recommendations and responses/explanations can be found in the enclosure to this MFF. Those recommendations requiring further analyses and/or more detailed explanations are explicitly addressed in the following sections.

There were three main IEPR comments pertaining to the economic analysis, with each comment having multiple recommendations in order to reach resolution on the comment. The outstanding issues requiring further research and which is the focus of this MFF can be categorized as follows:

1. The uncertainty in benefits of each alternative associated with reducing damages to the high-value industrial structures in economic impact area (EIA) F.
2. The uncertainty in the overall benefits of each alternative in light of the asymmetrical distribution and large range of damages/benefits as indicated by the HEC-FDA modeling results.
3. The impact to damages/benefits/net benefits/benefit-to-cost ratios of each alternative due to revised floodplains.
4. Method/data used to calculate advanced bridge replacement benefits.

The issues and results of the analyses are presented in more detail below.

1. **Benefits Associated with High-Value Industrial Structures**

   a. **Summary of Issue:** There is significant amount of uncertainty in the benefits associated with the high-value industrial structures located in economic impact area F. The economic modeling indicates that when these structures are flooded, a substantial amount of damages are incurred. The uncertainty surrounding the magnitude of flooding of these structures is significant and can be seen in the relatively high uncertainty in the hydrology as measured by the equivalent record length in HEC-FDA and the in-channel stages as indicated by the hydraulic rating curve. The relatively high uncertainty in the magnitude of flooding of the industrial structures is being reflected in the asymmetrical distribution of benefits as indicated by the significantly higher mean (expected) value as compared to the median value.

   b. **Response to Issue:** A sensitivity analysis was performed, which removed completely the industrial structures from EIA F. This was done in order to demonstrate the effects on net benefits and benefit-to-cost ratios (BCR) for Alternatives 2A, 2Aa, 2B, 4, and 5.

Since it is highly unlikely that all of the industrial structures would be considered out of the floodplain, the results of the sensitivity analysis are a conservative estimate of damages and benefits.

c. **Results of Analysis:** The information in Table 1 below is copied from Table 8.3 from the main Economic Appendix, with Alternative 2Aa (from Attachment D of Economic Appendix) also included.

Table 1: Annual Benefits and Costs by Alternative (October 2012 Prices, In $1,000s, 50-Year Period of Analysis, Discount Rate of 3.75%)

Item	Alternative 2A	Alternative 2Aa	Alternative 2B	Alternative 4	Alternative 5
Total Project Cost	27,684	20,965	64,383	98,470	96,020
Annual FRM Benefits	10,937	9,741	11,824	11,824	13,587
Savings in NFIP Admin. Costs	0	0	0	0	0
Advanced Bridge Repl. Ben.	13	0	130	130	35
Total Annual Benefits	10,950	9,741	11,954	11,954	13,622
Total Annual Costs	1,297	1,030	2,949	4,478	4,333
Net Benefits	9,653	8,711	9,005	7,476	9,289
BCR	8.4	9.5	4.1	2.7	3.1

Table 2 below replicates Table 1 above, but shows the net benefit/BCR analyses with the industrial structures removed from economic impact area F.

Table 2: Annual Benefits and Costs by Alternative (October 2012 Prices, In $1,000s, 50-Year Period of Analysis, Discount Rate of 3.75%) – Industrial Structures in EIA F Removed from the Analysis

Item	Alternative 2A	Alternative 2Aa	Alternative 2B	Alternative 4	Alternative 5
Total Project Cost	27,684	20,965	64,383	98,470	96,020
Annual FRM Benefits	5,544	4,446	5,752	5,752	7,518
Savings in NFIP Admin. Costs	0	0	0	0	0
Advanced Bridge Repl. Ben.	13	0	130	130	35
Total Annual Benefits	5,557	4,446	5,882	5,882	7,553
Total Annual Costs	1,297	1,030	2,949	4,478	4,333
Net Benefits	4,260	3,416	2,933	1,404	3,220
BCR	4.3	4.3	2.0	1.3	1.7

The results of the sensitivity analysis indicate that all alternatives are still economically feasible, even with the industrial structures in EIA F removed from the analysis. Alternative 2A is still the plan that maximizes net benefits. It has net benefits of about $4.3 million (reduced from about $9.7 million); its BCR drops from about 8.4 to 4.3.

2. **Asymmetrical Distribution of Damages Reduced (Benefits) of Each Alternative**

   a. **Summary of Issue:** The HEC-FDA modeling indicates an asymmetrical distribution of damages reduced (benefits) in which the mean (average) damages reduced is significantly greater than the median damages reduced for each alternative.

   b. **Response to Issue:** The HEC-FDA models were re-run to verify the without-project damages and with-project damages reduced (benefits). The model runs indicate a large difference in results when computed with risk as compared to when computed without risk in HEC-FDA. The large difference can be partly attributed to 1) the relatively high uncertainty in the hydrology (discharges) as reflected in the 35-year equivalent record used in the HEC-FDA modeling and 2) the relatively high uncertainty in the in-channel stages (between 0.5 and 0.9 feet) for specific exceedance probability events.

   Additionally, the relatively high degree of uncertainty in the in-channel (exterior) hydrology and hydraulics, the relatively shallow depths of interior flooding, the existence of several high-value industrial structures in the area, and the modeling technique used to transition from zero depth of flooding at these structures to flooding at these structures are all most likely contributing to the large spread in without-project damages and the asymmetrical distribution of benefits.

   Due to the high degree of uncertainty, a sensitivity analysis was performed using the annual benefits associated with the 75% confidence level (i.e., there is a 75% chance the benefits exceed a specific value). Net benefit and BCR analyses were performed using this more conservative benefit estimate in order to demonstrate the feasibility (or non-feasibility) of each alternative.

   c. **Results of Analysis:** Table 3 below displays the net benefit and BCR analyses for each alternative using the annual benefit value in which there is a 75% chance of it being exceeded.

Table 3: Annual Benefits and Costs by Alternative (October 2012 Prices, In $1,000s, 50-Year Period of Analysis, Discount Rate of 3.75%) – Annul FRM Benefit Values Shown in Table Have a 75% Chance of Being Exceeded.

Item	Alternative 2A	Alternative 2Aa	Alternative 2B	Alternative 4	Alternative 5
Total Project Cost	27,684	20,965	64,383	98,470	96,020
Annual FRM Benefits	2,689	2,447	N/A	N/A	2,973
Savings in NFIP Admin. Costs	0	0	0	0	0
Advanced Bridge Repl. Ben.	13	0	130	130	35
Total Annual Benefits	2,702	2,447	N/A	N/A	3,008
Total Annual Costs	1,297	1,030	2,949	4,478	4,333
Net Benefits	1,405	1,417	N/A	N/A	(1,325)
BCR	2.1	2.4	N/A	N/A	0.7

The results indicate that Alternatives 2A and 2Aa have positive net benefits and a BCR above unity; the net benefits for Alternative 5, however, are now negative, making it economically infeasible under this scenario. (Alternatives 2B and 4 were not analyzed for this scenario since these alternatives have "over-built" designs and show no residual flooding.)

3. **Revised Floodplains and Their Impact on Net Benefits**

    a. **Summary of Issue:** During the IEPR it was determined that the FLO-2D boundaries as modeled include artificial barriers that confine water flow within the study area, which could affect the economic analysis.

    b. **Response to Issue:** The District's Hydraulic Design Section performed a "rough cut" sensitivity analysis by taking out the artificial barriers and regenerating without-project and with-project (Alternatives 2A, 2Aa, and 5) floodplains for the downstream areas (EIAs E and F). The only change was to the floodplains; all other engineering data from the original analysis were carried forward to this sensitivity analysis. Using the revised suites of floodplains, the economic HEC-FDA models for EIA E and F were re-run. The without-project and with-project EAD results were then compared to the results from the original analysis.

    c. **Results of Analysis:** Table 4 below compares the EAD results using the original floodplains to the results using the revised floodplains. The largest difference in terms of EAD is occurring in economic impact area E, where there could potentially be a 20% reduction in without-project EAD. There is only a negligible change in EAD in economic impact area F.

Table 4: Comparison of EAD Using Original Floodplains and Revised Floodplains (October 2012 Price Level, In $1,000s)

Plan	Expected Annual Damages (EAD)					
	Economic Impact Area E			Economic Impact Area F		
	Original Floodplains (with artificial barriers)	Revised Floodplains (no artificial barriers)	Change (Δ)	Original Floodplains (with artificial barriers)	Revised Floodplains (no artificial barriers	% Change (Δ)
WO-Project	5,127	4,109	-20%	6,566	6,456	-2%
Alt. 2A	84	142	+69%	708	699	-1%
Alt. 2Aa	1,113	932	-16%	873	847	-3%
Alt. 5	253	200	-21%	3	3	No change

Table 5 below, which replicates Table 1 with the addition of two rows showing the revised EAD values from Table 4 above, displays the adjusted net benefit and BCR analyses. The analysis indicates that Alternative 2A remains the plan with the most net benefits.

Table 5: Comparison of Net Benefits and BCRs Using Revise EADs and Benefits Based on Revised Floodplains (October 2012 Price Level, In $1,000s, Federal Discount Rate of 3.75%)

Item	Alternative 2A	Alternative 2Aa	Alternative 2B	Alternative 4	Alternative 5[1]
Total Project Cost	27,684	20,965	64,383	98,470	96,020
Total EAD (EIAs E and F)	10,565	10,565	10,565	10,565	13,102
Residual EAD (EIAs E and F)	841	1,779	0	0	657
Annual FRM Benefits	9,724	8,786	10,565	10,565	12,445
Savings in NFIP Admin. Costs	0	0	0	0	0
Advanced Bridge Repl. Ben.	13	0	130	130	35
Total Annual Benefits	9,737	8,786	10,695	10,695	12,480
Total Annual Costs	1,297	1,030	2,949	4,478	4,333
Net Benefits	8,440	7,756	7,746	6,217	8,147
BCR	7.5	8.5	3.6	2.4	2.9

[1] Since Alternative 5 includes FRM improvements to both the downstream and upstream reaches of the study area, EAD values in Table 5 include the $10.6 million (EIAs E and F) from Table 4 plus the EAD values ($2.5 EAD and $.5 million residual EAD) from the upstream reaches (A, B, C, D) displayed in Table 7.1 of the main Economic Appendix; Alternative 5 provides benefits to both the upstream and downstream economic impact areas.

4. **Advanced Bridge Replacement Benefits**

   a. **Summary of Issue:** Bridge replacements are required in several of the alternatives. When a bridge is replaced before the end of its useful life, advanced bridge replacement benefits can be claimed. The methodology used to derive these benefits should be clearly explained.

b. **Response to Issue:** Advanced bridge replacement benefits comprise only a small portion of total benefits. In fact for all alternatives, advanced bridge replacement benefits do not exceed more than 1% of total benefits. The methodology used to calculate bridge benefits is the one outlined in the Institute for Water Resources (IWR) Report 88-R-2 and is currently the standard approach used by many Corps economists.

An example of the calculation process for one of the bridges being replaced under Alternative 2A is provided in the next section.

c. **Results of Analysis:** Table 6 below displays the data and the calculation process used to derive advanced bridge replacement benefits. The Old Piedmont Bridge in Alternative 5 is used as an example. The advanced bridge replacement benefits for all of the other bridges were calculated using the same method.

Table 6: Advanced Bridge Replacement Benefits for Old Piedmont Bridge (October 2012 Price Level, Federal Discount Rate of 3.75%)

Row	Item	Value	Calculation
A	Cost of Bridge	$708,589	
B	Life of Bridge	50	
C	Remaining Life of Existing	26	
D	Extension of Bridge Life	24	
E	Interest Rate	3.75%	
F	Capital Recovery Factor 50 years	0.0446	
G	Annual Cost of New Bridge	$31,585	A*F
H	Present Worth of Annuity Factor	15.64482	H
I	Benefits to Extension	$494,139	G*H
J	Single Payment Present Worth Factor	0.384	J
K	Present Worth Year 1 of Extension	$189,740	I*J
L	Annual O&M Existing	$0	
M	Annual O&M New	$0	
N	Annual O&M Savings	$0	
O	Present Worth of Annuity Factor	16.42	
P	Present Worth Year 1 of O&M	$0	
Q	Present Worth of Total Benefits	$189,740	K+P
R	**Average Annual Benefit**	**$8,457**	F*Q

Any questions regarding the information contained in this MFF may be directed to Timi Shimabukuro at (916) 557-5313.

Timi Shimabukuro
Economics & Risk Analysis Section
USACE Sacramento District

ENCLOSED:
Economics IEPR Comments/Responses

Final Panel Comment 3

The National Economic Development benefits cannot be validated due to inconsistencies and incomplete data associated with the calculation of the Annual Equivalent Damages.

Basis for Comment:

The Panel identified several issues pertaining to the calculation of Annual Equivalent Damages (AED, the key component of National Economic Development [NED] benefits) and the presentation of the results of the economic analysis that could significantly impact the findings and understanding of the economic analysis.

The total damages for Economic Impact Areas E and F are inconsistent with the total expected annual damages for these areas. Economic Impact Area E incurred damages at lower frequency events and incurred significantly higher total damages at each frequency event than Area F (Appendix C, Table 6.1), indicating that Area E would incur higher total expected annual damages than Area F. However, total expected annual damages are reported as being higher in Area F ($6.566M) than in Area E ($5.127M) (Appendix C, Table 6.2, p. 6-3).

The analysis indicated significant increases in structure and content damages resulting from only slight increases in stages. In Table 4.5 (Appendix C), a stage difference of only 0.06 foot between the 0.005 and 0.002 events in Area E results in an increase in damages of $23.6M. The difference in stage between the 0.040 and 0.002 events is only 0.57 foot, but increases damages from $8.57M to $94.06M. For Area F (Appendix C, Table 4.6), a change in stage of only 0.22 foot between the 0.040 and 0.002 events results in damages of $98.31M. Based on the depth damage curves used in the analysis, slight increases in stage should not result in significant increases in structure and content damages.

Advance bridge replacement benefits are included in the NED benefit calculations based on extending the remaining life of four existing bridges. No data are provided on how the remaining life of the bridges was estimated or how the benefits were calculated. The report indicates that these benefits were calculated following procedures of the Institute for Water Resources (IWR) Report 88-R-2 (USACE, 1988). The guidance used to calculate these benefits is out of date. The updated IWR manual (USACE, 2010b), and Engineer Regulation 1105-2-100 (USACE, 2000 are silent on advanced bridge replacement benefits.

Certain results of the analysis are presented inconsistently, or are not presented at all:

- Table 6.1 (Appendix C) presents damages for exceedance probability events that were not cited as being modeled for this analysis.
- Tables 4.1 - 4.6 (Appendix C, pp. 4-3 to 4-5) exclude damages for the events between the non-damaging and the 0.040 event. As a result, the extent of expected damages for each alternative are not adequately described.
- The supporting data used to develop the with-project equivalent annual damages in Table 7.1 (App. C) are not provided.

To allow a comprehensive understanding of the NED benefits and project justification, the results of the economic analysis should be presented in a consistent and complete manner.

Significance – High:

The inability to validate the NED benefits affects the calculation of the benefit-to-cost ratio and the selection of the NED, or recommended plan.

Recommendations for Resolution:

1. Ensure consistency in reported damages in Tables 6.1 and 6.2 (Appendix C).
2. Explain the significant increases in structure and content damages resulting from slight increases in stage.
3. Describe the method used to calculate the advance bridge replacement benefits.
4. Present damages in Table 6.1 (Appendix C) by exceedance probability events that are consistent with the remainder of the report.
5. Revise Tables 4.1 - 4.6 (Appendix C) to include damages for the events between the non-damaging and the 0.040 exceedance probability events.
6. Provide the supporting data used to develop the with-project equivalent annual damages in Table 7.1 (Appendix C).

PDT Draft Evaluator Response (FPC#3):

1. Please indicate below whether the PDT 'concurs' or 'non-concurs' with the comment statement in the first row above and provide a <u>clear explanation</u> for the 'concur' or 'non-concur' response.

_X_Concur __Non-Concur

Explanation: The Economic Appendix requires a clearer explanation and presentation of the data and methodologies used to develop the without-project equivalent annual damages (EAD), which serves as the baseline for estimating National Economic Development (NED) benefits.

2. For each recommendation, please indicate whether the PDT will 'adopt' or 'not adopt' the recommendation and provide an explanation. If 'adopt', please provide information on how this recommendation will be adopted. If 'not adopt', please explain why.

Recommendation #1: _X_Adopt __Not adopt
Explanation:

Additional explanation and clarification will be provided in the Economic Appendix regarding the apparent contradiction between exceedance probability event damages as reported in Table 6.1 and expected annual damages as reported in Table 6.2.

Clarification will focus on the following:

1) Refer the reader to Tables 4.5 and 4.6, which display the single-event damages for impact areas E and F, respectively. These tables show that damages in impact area F begin at around the 5-year event, without considering uncertainty in the hydrology and hydraulics, and that damages in impact area E begin at around the 10-year event, without considering uncertainty.
2) Clarify that Table 6.1 displays the exceedance probability-damage curves, which include uncertainty in the hydrology, hydraulics, and economics.
3) Point out that the exceedance probability-damage curve for impact area E is in fact "above" that of impact area F's curve – in other words, this would imply greater expected annual damages (for a single sampling of this expected curve) for impact area E.
4) Point out that expected damages for all categories except the industrial category are greater in impact area E than in impact area F.
5) Explain that there is considerable uncertainty in the damages associated with several industrial structures, which is being reflected in the expected annual damages for this category, and hence the higher expected annual damages for impact area F as compared to impact area E.

Recommendation #2: _X_Adopt __Not adopt
Explanation:

Additional information will be included in the Economic Appendix describing the technique used to compute stage-damage curves within HEC-FDA.

This technique involved:

1) Using FLO-2D output and grid cells to link depth of flooding to individual structures for a range of frequency events
2) Using exterior (in-channel) stages from rating curves to link exterior stages to interior (floodplain) damages

Also, additional information will be included in the Economic Appendix and will focus on explaining the association of in-channel stages to floodplain damages:

1) FLO-2D was used to generate floodplains -- water surface elevations by grid cells and frequency events. Structures were then tied to individual grid cells (water surface elevations), and this inventory was imported into HEC-FDA. In order to compute/scale stage-damage curves in HEC-FDA, exterior (in-channel) stages (from the rating curve) were linked to interior (floodplain) water surface elevations by event.

   This grid cell approach in FLO-2D is not proportional. For example, the river stage may increase by a certain stage but grid cell water surface elevations in FLO-2D may increase by a greater amount, hence the increase in damages.

2) The stages on the depth-percent damage curves are interior (floodplain) stages;

the stages in the rating curve are exterior (in-channel) stages. Increases in exterior (in-channel) stages do not necessarily translate into proportionate increases in interior (floodplain) water surface elevations.

Recommendation #3: _X_ Adopt __Not adopt
Explanation:

The method used to calculate advanced bridge replacement benefits is outlined in IWR Report 88-R-2 and is currently the standard approach used in the Corps.

Additional information will be included in the Economic Appendix describing the data used and showing the steps taken to calculate advanced bridge replacement benefits. Data will be provided for all bridges; a step-by-step example using one bridge (Old Piedmont Bridge) will be shown.

Recommendation #4: __Adopt _X_ Not adopt
Explanation:

The exceedance probability-damage curves displayed in Table 6.1 are output results from the HEC-FDA models. Through its internal calculation processes (interpolation and extrapolation), HEC-FDA computes damages for a range of exceedance probability events (0.999 to 0.001) based on user-provided data. The exceedance probability events listed in Table 6.1 are not user-provided data points.

Recommendation #5: _X_ Adopt __Not adopt
Explanation:

Tables 4.1 to 4.6 will be revised to include damages for the events between the non-damaging exceedance probability event and the 0.04 exceedance probability event.

Recommendation #6: _X_ Adopt __Not adopt
Explanation:

Additional explanation will be included in the Economic Appendix explaining where the equivalent annual damages in Table 7.1 came from.

In Table 7.1, equivalent annual damages for the areas upstream of I-680 (areas A, B, C, and D) were taken from Table 6.2 (total expected annual damages) and summed; areas A, B, C, and D did not include any future development, so expected annual damages are equal to equivalent annual damages.

To summarize equivalent annual damages for areas upstream of I-680:

Area A = 22 (from Table 6.2)
Area B = 1,054 (from Table 6.2)
Area C = 42 (from Table 6.2)

Area D = 1,418 (from Table 6.2)
Total EAD = 2,536

Also in Table 7.1, equivalent annual damages for the areas downstream of I-680 (areas E and F) were taken from Table 6.2 (total expected damages for area F) and Table 6.3 (total equivalent annual damages for area E) and summed; area F did not include any future development, so expected annual damages are equal to equivalent annual damages; area E did include future development (midtown Milpitas), so an equivalent annual damage analysis was performed.

To summarize equivalent annual damages for areas downstream of I-680:

Area E = 5,258 (from Table 6.3)
Area F = 6,566 (from Table 6.2)
Total EAD = 11,824

The National Economic Development benefits cannot be validated due to inconsistencies and incomplete data in the economic risk and uncertainty analysis.

Basis for Comment:

Review of the General Reevaluation Report (GRR) and Appendix C of the GRR identified several issues pertaining to the incorporation of risk and uncertainty into the calculation of the Annual Equivalent Damages (AED) that could significantly affect the findings of the economic analysis.

The reported risks associated with implementing Alternatives 2B/d and 4/d are inconsistent with EM 1110-2-1619 (USACE, 1996) and statements in the GRR. Table 6-11 (GRR, p. 6-24) indicates Alternatives 2B/d and 4/d have no with-project residual damages, residual risk of annual exceedance probability (AEP), chance of flooding in any year, or long-term risk, and 100% conditional non-exceedance. Alternatives 2B/d and 4/d result in no residual damages (GRR, p. 3-50), indicating that the probability of capacity exceedance is zero. In accordance with EM 1110-2-1619, however, the probability of capacity exceedance is never zero and the performance of any measure is never a certainty. Furthermore, the GRR (p. 3-71) states, "There is always the risk of residual flooding regardless of how large a project is built."

The introduction of risk and uncertainty into the analysis results in significant increases in total damages. There is a significant increase in total damages, by event (up to nearly 7 times increase for certain events), presented in Table 6.1 (p. 6-2 of Appendix C), which includes the incorporation of risk and uncertainty, compared to damages presented in Tables 4.1 through 4.5 (pp. 4-3 to 4-5 of Appendix C), which were estimated prior to the incorporation of risk and uncertainty into the economic analysis. In Table 4.5, the 0.002 event results in damages equivalent to 6.5% of the inventory for Area E, compared to 31% of the inventory in Table 6.1. For Area F, Table 4.6 indicates 0.002 event damages equivalent to 16% of the inventory, compared to 49% in Table 6.1. The incorporation of risk and uncertainty should provide additional information on the overall range of potential results, but not result in a significant change in the mean value of total damages.

The mean benefits for Alternatives 2A and 5 are inconsistent with the probability distribution describing those benefits. In Table 7.3 (Appendix C, p.7-4), the mean benefits of Alternative 2A are reported as $10.93M, with only a 50% chance that benefits will exceed $3.337M, and only a 25% chance that benefits will exceed $8.068M. The mean benefits of Alternative 5 are reported as $11.5M, with only a 50% chance that benefits will exceed $3.71M, and only a 25% chance that benefits will exceed $8.359M. The 50% probability value would be expected to more closely align with the mean value, and the 25% probability value should significantly exceed the mean value, as is the case with Tables 18 and 19 (Appendix C, pp. C-4 and C-5) and examples presented in ER 1105-2-101.

Risk and uncertainty are not incorporated into the future economic development

conditions (Appendix C, Chapter 5 and Section 6.3).

To allow a comprehensive understanding of the National Economic Development (NED) benefits and project justification, the results of the risk and uncertainty analysis should be presented in accordance with guidance. Net NED benefits, benefit-to-cost ratios, inundation maps showing flood depths (should the project be exceeded), and a narrative scenario for events that exceed the project design are not presented, as required in ER 1105-2-101 (USACE, 2006).

Significance – High:

The inability to validate the NED benefits affects the calculation of the benefit-to-cost ratio and the selection of the NED, or recommended plan.

Recommendations for Resolution:

1. Report the risk associated with implementing Alternatives 2B/d and 4/d to ensure compliance with EM 1110-2-1619 and resolve conflicting statements in the GRR.
2. Verify the significant increase in mean benefit without and with incorporating risk and uncertainty, and explain how the mean benefits increased significantly due to incorporation of risk and uncertainty.
3. Verify the reported single expected value and probabilistic net benefits for Alternatives 5 and 2A, or explain how the mean benefits can be greater than 75% of the values in the probability distribution.
4. Incorporate risk and uncertainty into the development of future conditions.
5. Present the results of the risk-based analysis in accordance with ER 1105-2-101.

PDT Draft Evaluator Response (FPC#4):

1. Please indicate below whether the PDT 'concurs' or 'non-concurs' with the comment statement in the first row above and provide a <u>clear explanation</u> for the 'concur' or 'non-concur' response.

X   Concur   ___Non-Concur

Explanation: The Economic Appendix requires an expanded explanation and presentation of the inputs and outputs of the economic risk analysis.

2. For each recommendation, please indicate whether the PDT will 'adopt' or 'not adopt' the recommendation and provide an explanation. If 'adopt', please provide information on how this recommendation will be adopted. If 'not adopt', please explain why.

Recommendation #1: _X_Adopt __Not adopt
Explanation:

The Economic Appendix will include clarifying statements:

   1) The FLO-2D modeling indicates that there are no residual floodplains with these

alternatives in place. Therefore, no economic modeling of these alternatives was performed.

2) Any type of modeling attempts to characterize what can happen in the "real world" as best as possible, but is not an exact representation of what will actually happen.

3) In the case of Berryessa, it is important to note that while the modeling indicates absolutely no residual risk for Alternatives 2B and 4, the reality is that no matter how "big" or "strong" a FRM project is thought to be, there is always the chance for residual flooding.

4) In terms of analyzing the final array of alternatives and identifying the NED plan, assuming zero residual risk for Alternatives 2B and 4 is a conservative approach to show that neither alternative provides the most net benefits to the Nation.

Recommendation #2: _X_Adopt __Not adopt
Explanation:

The HEC-FDA models were re-run to verify without-project damages and with-project damages reduced (benefits). Without-project damages and with-project damages reduced were re-computed under both a "without risk" scenario and a "with risk" scenario. The results indicate that there is a large increase in damages/damages reduced when computed with risk. This increase can be attributed to the relatively high uncertainty in the hydrology (35 year equivalent record length) and the in-channel stages for specific exceedance probability events (between 0.5 feet and 0.9 feet), which is being reflected in the large range in benefits for alternative 2A and 5 as shown in Table 7.3.

Additionally, the large spreads in damages can be attributable to several factors, including (1) shallow flood levels (2) several large value industrial buildings (3) FLO-2D water surface elevation (WSE) transition from no flood depth to flooding within HEC-FDA. In the without risk case many structures are on the borderline showing no inundation damage. As HEC-FDA develops stage-damage functions for these structures it shows no damages below the borderline frequency WSE. In the risk version, these structures have a probability of inundation as the first floor elevation adjusts to the uncertainty range (.5') entered into the model. This risk factor coupled with several multi-million dollar structures at the borderline will cause a significant difference between the no risk and with risk results.

Recommendation #3: _X_Adopt __Not adopt
Explanation:

The expected damages reduced (benefits) were verified in the HEC-FDA models. There is relatively high uncertainty associated with the hydrology and hydraulics as modeled in HEC-FDA. The large range in benefits and the non-alignment of expected benefits with median benefits (50% probability benefits) reflect this uncertainty.

A more detailed explanation of the expected benefit results and the role uncertainty

plays in the results will be included in the Economic Appendix.

Additionally, the tables in Chapter 8 of the Economic Appendix showing the net benefit and benefit-to-cost analyses of Alternative 2A (the plan identified as the NED) will be expanded to include an analysis using the 75% probability benefits. This is intended to provide more information regarding the economic feasibility of Alternative 2A using a more conservative estimate of benefits, especially in light of the uncertainty involved.

Much of the uncertainty in benefits can be associated with the high-value industrial structures located in the study area. The economic modeling indicates that when in fact these structures are flooded, they incur a substantial amount of damages. The uncertainty surrounding whether or not these structures are flooded is significant, as can be seen by the relatively high uncertainty in the hydrology (as measured by the equivalent record length in HEC-FDA) and the relatively high uncertainty in in-channel stages (as indicated by the hydraulic rating curve). The relatively high degree of uncertainty in the hydrology and hydraulics and how this uncertainty is being reflected in an "asymmetrical probability distribution" of damages/benefits associated with the industrial structures will be described in greater detail in the Economic Appendix.

A sensitivity analysis will be performed with the industrial structures and will be described in the Economic Appendix. In this sensitivity analysis, the industrial structures will be removed from the net benefit and benefit-to-cost analyses in order to show the effects on net benefits and the BCR. This is an extreme (or worst case) scenario, and assumes that the industrial structures will never be flooded. (As indicated above, another table showing the net benefits and benefit-to-cost analyses using the benefits associated with the 75% confidence level will also be included in the Economic Appendix. The analyst believes that this is a more reasonable scenario.)

Recommendation #4: _X_ Adopt __Not adopt
Explanation:

Risk analysis was performed in HEC-FDA to compute equivalent annual damages and benefits related to the future development in the Milpitas Midtown area. It is important to note that damages or benefits were NOT claimed from flooding to these structures from an event smaller than a 100-year; also, it is important to note that benefits associated with future development comprise only a very small portion of total benefits. In fact, removing these benefits from the analysis would not significantly affect the net benefit or benefit-to-cost analyses. This will be clarified in the Economic Appendix.

Engineering evaluations indicate that future hydrology (change in flow) would be insignificant in the study area. For economic modeling purposes, the current year and most likely future year (2020) without-project engineering curves (exceedance probability-discharge and stage-discharge) and event floodplains were assumed the same. Future year (2020) stage-damage curves were computed in HEC-FDA using the engineering curves/floodplains and the inventory of the future development.

Recommendation #5: _X_ Adopt __Not adopt
Explanation:

The tables in Chapter 8 of the Economic Appendix display the net benefit and benefit-to-cost analyses of the alternatives. ER 1105-2-101 will be used as a guide to better explain the risk analysis results. Floodplains for a range of exceedance probability events were provided in the Hydraulic Design Appendix.

The National Economic Development benefits cannot be validated because detailed documentation associated with the development of the structure inventory, content value surveys, and structure valuation is not provided.

Basis for Comment:

Appendix C of the General Reevaluation Report (GRR) lacks (1) information on the methods used to develop the structure inventory and conduct and verify the content survey, (2) a detailed description of the calculation of structure values, and (3) the dates that the structure inventory, the site visits, and the content survey were conducted. The Panel is thus unable to determine if the structure and content data used in the analysis are accurate and if they reflect the current conditions in the study area, which could affect the calculation of the National Economic Development (NED) benefits.

The Panel was unable to determine if all structures and content in the study area are included in the analysis. A portion of the study area bounded by Economic Impact Area E, Economic Impact Area F, and Berryessa Creek is excluded from an Economic Impact Area (Appendix C, Figure 2.1, p. 2-2). The rationale for excluding this area from an Economic Impact Area is not provided. Excluding structures subject to inundation from the study area could result in the underestimation of NED benefits.

The following details are not found in the documentation of the development of the structure inventory:

- The date of the "previously completed" structure inventory. There is no indication that the characteristics of the structure inventory were verified in recent years (Appendix C, Section 2.2, p. 2-4).
- The date of the "on-site inspection of all the structures within the floodplain" (Appendix C, Section 2.2, p. 2-4).
- A description of how the structure inventory was developed, in accordance with Section 308 of WRDA 1990, or how structures built after July 1, 1991 were identified (Appendix C, p. 2-4).
- The portion of the additional 1,000 structures at risk since the conduct of the 1987 Feasibility study, which were constructed after July 1, 1991 (Appendix C, p. 2-5).
- The date and source of the structure data used to develop the Marshall & Swift Valuation Service structure valuations (Appendix C, p. 2-6).
- The method for valuing structures built since the conduct of the "previously completed" structure inventory (Appendix C, p. 2-6).
- The basis for estimating the effective age of structures to determine depreciation factors for use in developing structure valuations in Marshall & Swift (Appendix C, p. 2-6).
- The impact, if any, of the 2008-2009 U.S. economic recession on housing values, and labor and construction costs in the area. (Appendix C, Section 2.3, p. 2-5 to 2-6)
- Detailed content surveys conducted for the 1992 General Design Memorandum

(GDM) to determine content percentages were not confirmed nor values adjusted for this analysis (Appendix C, Section 2.4, p. 2-7 of App. C and p. 2-22 of GRR). Use of content data from 1992 for technology industries may underestimate actual values.

- No known flood events have occurred in the study area that have resulted in non-residential damages; therefore, non-residential content values and estimated loss for various flood events are based on best-guess estimates of respondents. The reasonableness of the best guess estimates used in the 1992 GDM appear to be based on the best-guess estimates themselves (Appendix C, Section 2.4, p. 2-7). Survey data on contents value and estimated loss for various flood events for non-residential content value are not independently verified.
- The total value of structures within the floodplain is given as over eight times the value found in the 1987 Feasibility study. The factors leading to the increase in valuation are cited as additional structures, general increases in valuation from 1986 to 2011, improvements in existing structures, and increased labor and construction costs in the area (Appendix C, p. 2-8). The portion of the increase attributable to each factor is not provided.
- The date and methods used during field visits to establish first floor structure elevations (Appendix C, Section 3.1, p. 3-1).
- Industrial content depth damage curves used in the original Corps study were modified based on the current survey responses (Appendix C, p. 3-2). No data were provided on the current survey responses or how the depth damage curves were modified.

Significance – High:

The inability to validate the NED benefits affects the calculation of the benefit-to-cost ratio and the selection of the NED, or recommended plan.

Recommendations for Resolution:

1. Provide the rationale for excluding a portion of the study area from an Economic Impact Area and indicate if structure and content values in that area are included in the analysis.
2. Provide the date that the "previously completed" structure inventory was performed. If the inventory is dated, describe any verification undertaken during this analysis to update the inventory.
3. Provide date of on-site inspection of structures.
4. Describe how the structure inventory was developed in accordance with Section 308, and how structures built after July 1, 1991 were identified.
5. Indicate the portion of the structure inventory constructed after July 1, 1991.
6. Provide the date and source of the structure data used to develop the Marshall & Swift Valuation Service structure valuations.
7. Indicate the method used to value structures built since the conduct of the "previously completed" structure inventory.
8. Provide the basis for estimating the effective age of structures.
9. Indicate the impact, if any, of the 2008-2009 U.S. economic recession on housing

values, and labor and construction costs in the area.

10. Provide the rationale for not confirming content percentages or adjusting content values developed for the 1992 GDM for use in this analysis.
11. Provide the rationale for not independently verifying the best-guess estimates from survey content data and estimated loss for various flood events for non-residential content value.
12. Indicate the portion of the increase in total value of structures within the floodplain since the 1987 Feasibility study that is attributable to each factor.
13. Provide the date and methods used during field visits to establish first floor structure elevations.
14. Provide data on the current survey responses that were used to modify the industrial content depth damage curves used in the original USACE study and how the depth damage curves were modified.

PDT Draft Evaluator Response (FPC#5):

1. Please indicate below whether the PDT 'concurs' or 'non-concurs' with the comment statement in the first row above and provide a <u>clear explanation</u> for the 'concur' or 'non-concur' response.

__X__ Concur   ___ Non-Concur

Explanation:

The Economic Appendix requires an expanded explanation and presentation of the methods used to develop the structure inventory and to estimate structure/content values.

2. For each recommendation, please indicate whether the PDT will 'adopt' or 'not adopt' the recommendation and provide an explanation. If 'adopt', please provide information on how this recommendation will be adopted. If 'not adopt', please explain why.

Recommendation #1: __X__ Adopt ___ Not adopt
Explanation:

The area is not part of the 500-year floodplain and any structures in that area are not included in the economic inventory.

Recommendation #2: __X__ Adopt ___ Not adopt
Explanation:

A comprehensive inventory was developed in 2000. Updates/verifications were completed in 2004 and 2008. Since 2008, only limited updating (price level) of the inventory has been performed. The area is considered built-out (except for the additional multifamily units in the Midtown Milpitas area).

Recommendation #3: __X__ Adopt ___ Not adopt

Explanation:

On-site inspections were last completed in 2004. Limited updates have been completed since then.

Recommendation #4: _X_Adopt __Not adopt
Explanation:

Data was collected mainly from assessor's parcel data, which includes the year the structure was built. Structures built after July 1991 were identified via the assessor's parcel data.

Recommendation #5: _X_Adopt __Not adopt
Explanation:

The structure inventory excludes structures built after July 1991, except for those related to future development in the Midtown Milpitas area. No damages or benefits were claimed from flood events at or below a 100-year for those structures slated for future development. No damages/benefits were claimed at all for any existing structures built after July 1991.

It is also recognized that benefits of each alternative could actually be greater than currently being reported if those structures built after 1991 were included in the inventory. The amount of damages (and damages reduced with a project in place) tied to these structures would most likely be minimal since the assumption is that they are above the 100-year water surface elevation and so would only sustain damages from less frequent events (lower than .01 exceedance probability).

Recommendation #6: _X_Adopt __Not adopt
Explanation:

Assessor's parcel data was used to develop the structure inventory. A comprehensive inventory was initially completed in 2004.

Recommendation #7: _X_Adopt __Not adopt
Explanation:

Future development in the Midtown Milpitas area includes multi-family residential (MFR) units. Each of these units/structures was valued at $200,000. This value was carried forward from the 2006 General Reevaluation Report and used in this analysis.

It is important to note that for those structures planned for future development, no damages/benefits were claimed due to flooding from events at or below the 100-year. Also, benefits tied to future development comprise a relatively insignificant amount (about 1%) of total benefits (Alternative 2A).

Recommendation #8: _X_Adopt __Not adopt
Explanation:

During the initial inventory development and through a combination of field work and assessor's parcel data, a qualitative estimation of condition (very good, good, poor, etc.) was made, which was then used to determine a depreciation percentage/remaining value percentage. These percentages were then used in the estimation of depreciated replacement values.

Recommendation #9: _X_Adopt __Not adopt
Explanation:

Any impact the 2008-2009 recession may have had on depreciated replacement values/construction costs in the area would be reflected in the Marshall & Swift factors used to update the structure values.

(During the 2008-2009 economic down turn, housing values in the San Francisco Bay Area did not see a precipitous decline as compared to other areas in California, especially in such Central Valley cities like Sacramento. Housing prices in the Bay Area have since stabilized and are now increasing.)

Recommendation #10: _X_Adopt __Not adopt
Explanation:

It is believed that the content-to-structure value ratios for non-residential categories taken from the 1992 GDM is the best available at this time.

This will be verified using other studies in the area (e.g., Upper Penitencia Creek FRM, Upper Guadalupe FRM) with similar type structures.

In addition, it is recognized that there is a significant amount of uncertainty associated with the flooding and subsequent damages/benefits to the high-value industrial structures in the study area. As described in the response to recommendation #3 (FCP #4), a sensitivity analysis will be performed on the industrial structures to see the impact removing them from the analysis has on net benefits and benefit-to-cost ratios.

Recommendation #11: _X_Adopt __Not adopt
Explanation:

It is believed that the survey data collected for the 1992 GDM is the best available at this time.

This will be verified using other studies in the area (e.g., Upper Penitencia Creek FRM, Upper Guadalupe FRM) with similar type structures.

Recommendation #12: _X_Adopt __Not adopt

Explanation:

The statements in the Economic Appendix describing the value of damageable property being eight times the value reported in the 1987 Feasibility Study may be based on incorrect information reported in the 1987 report. The increase in value may be closer to 2.5 times. This will be verified.

An additional table will be included in Appendix C, Section 2.4 comparing the structure counts, structure types, and value of damageable property between the 1987 Feasibility Study and this current analysis.

Recommendation #13: _X_Adopt __Not adopt
Explanation:

Field work was completed during the 2004 update. Foundation heights were estimated for each structure using 0.5 foot increments during the field visits; "window" surveys were used to estimate foundation heights. Using Geographic Information Systems (GIS), ground elevations were assigned to each structure. Both ground elevations and foundation heights were imported into the HEC-FDA models; through its computation processes, HEC-FDA calculates first-floor elevations (ground elevation plus foundation height) for each structure.

Recommendation #14: __Adopt X_Not adopt
Explanation:

The industrial content depth-percent damage curves used in the original USACE study were modified during past efforts (not this current effort) using content survey responses; this survey was also completed during past efforts and not during this current analysis. While this survey data is not readily available, depth- percent damage curves will be reviewed for reasonableness by comparing them to those used in other studies in the area that also have similar high-tech occupancy types.

(Also, please see response to recommendation 10 for additional explanation.)